Printed on Thin Paper for Foreign Circulation

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXIII.—No. 3457] LONDON: FRIDAY EVENING, MARCH 31, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Centenary of Naval Engineering.

Aviation and National Defence.

The International Railway Association.

The Institute of Metals.—No. IV.

Future of the British Locomotive Trade.

Recent Developments in Power Station Design.—No. XXVI.

Worm Reduction and Change Speed Gearing.

Reinforced Concrete Gas Producer.

Indian Engineering Notes.

British and American Locomotive Design.

10-Ton Breakdown Crane.

PUBLIC NOTICES

TO CONTRACTORS ONLY.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 4th May, 1922, for the SUPPLY of ENGINEERING LABOUR during the period of three years in the following districts :—
LEEDS (MECHANICAL).
NEWCASTLE (ELECTRICAL AND MECHANICAL).
SOUTHAMPTON (ELECTRICAL AND MECHANICAL).
Forms of Tender, &c., may be obtained on application to the Contracts Branch, H.M. OFFICE OF WORKS, King Charles-street, London, S.W. 1. 7804

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—
1. RODS, POINT, for SIGNAL APPARATUS.
2. ENGINES, LOCOMOTIVE.
Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 21st April, 1922, for No. 1, and on Tuesday, the 2nd May, 1922, for No. 2.
T. RYAN,
7810 Director-General.

Civil Engineer Required by the GOVERNMENT of ZANZIBAR for one tour of 20 to 30 months' service as an ASSISTANT ENGINEER on WATER SUPPLY. Salary £700 per annum. Free quarters and first-class passages.
Candidates, preferably single, must be A.M. Inst. C.E. or possess similar professional qualifications, and must have had good practical experience on Waterworks. The person appointed will be required to lay out and supervise the construction of waterworks, pipe line and other details.
Apply at once, in writing, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/Zanzibar 11,271. 7782

The University of Liverpool.
MUNITIONS COMMITTEE FELLOWSHIPS IN ENGINEERING.
APPLICATIONS are INVITED for these FELLOWSHIPS (two in number) from persons qualified to undertake research in any department of engineering. The Fellowships are tenable in the first place for one year (value £250 each) and may be renewed for a second year (£350 each). Form of application and full particulars may be obtained from the Registrar, The University of Liverpool, to whom application should be forwarded before 1st June, 1922.
EDWARD CAREY,
7779 Registrar.

Bengal-Nagpur Railway Company, Limited.
The Directors are prepared to receive TENDERS for all or any of the following :—
OPEN and COVERED GOODS WAGONS and BRAKE VAN UNDERFRAMES, 2ft. 6in. gauge.
Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 27th March, 1922.
A fee of £1 1s. will be charged for the specification, which will not be returned.
Tenders must be submitted not later than Noon on Monday, 10th April, 1922.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
R. C. VOLKERS,
7773 For Managing Director.

County Borough of Croydon.
SELHURST PUMPING STATION.
GAS ENGINE AND PUMPS.
Notice is hereby given that the Council are prepared to receive TENDERS for the SUPPLY and ERECTION of a GAS ENGINE and PRODUCER PLANT, with DEEP WELL PUMPS and SURFACE PUMPS for pumping water from well into service mains of the town.
Specifications, conditions and form of Tender may be obtained on application at the Borough Engineer's Office, Town Hall, Croydon, upon payment of a deposit of One Guinea, which will be returned upon receipt of a bona fide Tender.
Tenders, on the prescribed form, to be sent to me by Eleven o'clock in the forenoon of Saturday, 22nd April, 1922, endorsed "Tender for Gas Engine and Pumps, Selhurst Pumping Station."
Tenders will only be received subject to the draft contract, specification and conditions deposited at my office and which may be inspected during office hours.
The Council will not be bound to accept the lowest or any Tender.
JOHN M. NEWNHAM,
Town Clerk.
Town Hall, Croydon,
28th March, 1922. 7793

Metropolitan Water Board.
TENDERS FOR OVERHAULING, REPAIR AND RENEWALS TO A COMPOUND WORTHINGTON PUMPING ENGINE AT HAMMERSMITH PUMPING STATION.
The Metropolitan Water Board invite TENDERS for OVERHAULING, REPAIR, and RENEWALS to a COMPOUND WORTHINGTON PUMPING ENGINE at their Hammersmith Pumping Station.
Forms of Tender, conditions of contract, specification, and drawing may be inspected without payment of fee at the Offices of the Board, Chief Engineer's Department, Room 182, New River Head, 173, Rosebery-avenue, Clerkenwell, E.C. 1, on and after Monday, April 3rd, 1922.
Contractors desirous of tendering may obtain the necessary documents from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of £1 1s., which sum must be deposited with the Board's Accountant and will be returned on receipt of a bona fide Tender, together with all incidental papers. Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m., Thursdays excepted (Saturdays, 10 a.m. and 12 noon).
Tenders, enclosed in sealed envelopes, addressed to The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Overhauling, Repair, and Renewals to a Compound Worthington Pumping Engine, Hammersmith," must be delivered at the Offices of the Board not later than 10 a.m. on Wednesday, April 19th, 1922.
W. MOON,
Clerk of the Board.
Offices of the Board,
173, Rosebery-avenue, E.C. 1.
27th March, 1922 7794

PUBLIC NOTICES

Stepney Borough Council.
ELECTRICITY SUPPLY.
(A) CONVERTING PLANTS.
(B) OVERHEAD CRANE.
The Electricity Supply Committee of the Stepney Borough Council invite TENDERS from responsible contractors for the CARRYING OUT of the following WORK :—
(a) The MANUFACTURE, SUPPLY, and ERECTION complete of THREE 1000 K.W. CONVERTING PLANTS suitable for converting E.H.T., 6000 volts, 3-phase A.C. current to L.T. D.C.
(b) The MANUFACTURE, SUPPLY, and ERECTION of ONE 50-Ton Electrically Driven OVERHEAD GANTRY CRANE with Gantry Girders and Rails; also the DISMANTLING and ALTERATION of an existing Hand-driven CRANE and the RE-ERECTION of the same at one of the Council's Sub-stations.
Copies of the general conditions, specifications, forms of Tender and drawings may be obtained from Mr. W. C. P. Tapper, M.I.E.E., Borough Electrical Engineer and Manager, No. 27, Osborn-street, Whitechapel, E. 1, upon receipt of a deposit of Two Guineas for each specification (a) and (b). Deposits will be returned to bona fide Tenderers after the Tenders have been considered by the Council. Additional copies may be obtained upon payment of the sum of 10s. 6d. per copy, which will not be returned. Copies of the specifications and drawings may be inspected at the above-mentioned address by appointment.
Tenders, on the form supplied, endorsed "Tender for Converting Plant" and "Tender for Crane," as the case may be, must be delivered, signed, sealed and addressed to the Chairman of the Electricity Supply Committee, at No. 27, Osborn-street, Whitechapel, E. 1, not later than Noon on April 20th, 1922.
The Council do not bind themselves to accept the lowest or any Tender.
GEO. W. CLARKE,
Town Clerk.
Municipal Offices,
Raine-street, Wapping, E. 1. 7804

County Borough of Birkenhead.
WATER COMMITTEE.
FOR SALE.
The Corporation are prepared to receive OFFERS for the following PUMPING PLANT, which is for disposal, owing to the coming into operation of a new gravitation supply, and is all in excellent working condition :—
A COMPOUND ROTATIVE BEAM ENGINE, surface condensing, with bucket and plunger pumps, capacity 80,000 gallons per hour, with a total lift of 363ft. at a boiler pressure of 90 lb. per square inch; H.P. cylinder, 30in. dia. by 3ft. 10in. stroke; L.P. cylinder, 58in. dia. by 7ft. stroke; bucket, 7ft. stroke.
TWO TRIPLE-EXPANSION HORIZONTAL DUPLEX PUMPS; steam cylinders, 10in., 16in. and 25in. dia.; water cylinder, 14in. dia. by 18in. stroke; capacity (each), 45,000 gallons per hour against a head of 200ft. at a boiler pressure of 150 lb. per square inch.
TWO SURFACE CONDENSERS, Wheeler Admiralty Pattern, 2ft. 4in. dia. by 6ft. 10in. between tube plates, 453 4in. copper tubes (each), with steam-driven Horizontal Air Pumps complete.
TWO LANCASHIRE BOILERS, 30ft. by 7ft., by Tellow Bros., insured for 150 lb. w.p.
ONE LANCASHIRE BOILER, by the Oldham Boiler Works Co., Ltd., insured for 100 lb. w.p.
TWO LANCASHIRE BOILERS, by the Oldham Boiler Works Co., Ltd., insured for 100 lb. w.p.
All the boilers above mentioned are fitted complete with Hopkinson valves and mountings.
Any further information and also permits to view the plant may be obtained from the BOROUGH WATER ENGINEER, 52, Balls-road, Birkenhead, to whom offers for the whole or portions of the plant should be sent not later than April 14th, 1922.
Water Engineer's Office,
15th March, 1922 7751

PUBLIC NOTICES

The Great Indian Peninsula RAILWAY COMPANY.
The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

No.		Fee for Specification.
1.	POINTS and CROSSINGS	£1
2.	GALVANISED W.I. WATER TUBES	10s.
3.	BRASS and IRON or STEEL SCREWS	10s.
4.	FENCING MATERIALS	10s.
5.	BELLOWS	2s. 6d.
6.	WHITE LEAD	£1
7.	GALVANISED CORRUGATED SHEETS, &c.	7s. 6d.
8.	SPRING STEEL	£1
9.	PIG IRON	2s. 6d.
10.	PLATE GLASS, &c.	10s.
11.	FENCING WIRE STRAND	7s. 6d.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.
The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.
Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Points and Crossings," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 11th April, 1922.
The Directors do not bind themselves to accept the lowest or any Tender.
R. H. WALPOLE,
Secretary.
Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 29th March, 1922. 7812

The Madras and Southern MAHRATTA RAILWAY CO., LTD.
The Directors are prepared to receive TENDERS for :—
(1) About 84 TONS PAINTS, DRIERS, &c.
(2) 2700 GALLONS VARNISHES.
In accordance with the specifications, which may be seen at the offices of the Company. The charge for each specification is One Guinea, which will not be returned.
Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, the 11th April, 1922, marked "Tender for Paints, &c.," or as the case may be.
The Directors do not bind themselves to accept the lowest or any Tender.
Company's Offices :
25, Buckingham Palace-road,
Westminster, S.W. 1,
27th March, 1922. 7792

British North Borneo.
REQUIRED IMMEDIATELY, in the PUBLIC WORKS DEPARTMENT of NORTH BORNEO, TWO ENGINEERS.
Candidates should be single and under 30 years of age; active, of good physique, with thorough knowledge of instrument work and well trained in ordinary engineering knowledge; must have been trained in a recognised engineering college and should have passed A.M.I.C.E. exam. or hold exempting degree; should have had good practical experience on public works. Preference for one appointment will be given to candidate with waterworks experience.
Salary £490, rising annually by £21, with house or house allowance and duty allowance of £56. Five years' agreement, with first-class free passage out and home on completion of agreement. Appointment subject to medical examination.
Apply (in writing) not later than 3rd April, with full record of career in chronological order, giving age and details of general and technical education, training and subsequent experience, testimonials (copies only), service certificates, &c., to Messrs. RENDEL, PALMER and TRITTON, 13-14, Dartmouth-street, S.W. 1 7652

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
MACHINE FOR MAKING OUTER CASINGS OF MATCH BOXES.
The Proprietors of British Letters Patent No. 16,936 of 1915 are prepared to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to a new method and machine for manufacturing the outer casing of match boxes in which the pressing roller accompanies the partially wound casing along the mandrel.
Address, B. W. & T.,
111/112, Hatton-garden,
7791 London, E.C. 1.

SITUATIONS OPEN

WANTED by an English Firm Carrying Out Large building contract in the Far East, a qualified ASSISTANT of good education.
Applicants must possess extensive experience in the conduct of building operations in Reinforced Concrete, with a thorough knowledge of Quantity Surveying; preference given to a man who has been with a firm of contractors and has carried out similar work abroad. Age 25-35.
Strict medical examination required before appointment.
Address, with full particulars of career, enclosing copies of not more than two recent testimonials, 7756, The Engineer Office. 7756 A

WANTED by an English Firm Carrying Out Large building contract in the Far East, a WORKS FOREMAN.
Applicants must possess a thorough knowledge of Ferro-concrete Building Construction on a large scale, with a wide experience of handling labour.
Preference given to an unmarried man with the necessary experience, who has carried out similar work abroad with native labour. Age not over 40. Strict medical examination required before appointment.
Address, with full particulars of career, enclosing copies of not more than two recent testimonials, 7737, The Engineer Office. 7737 A

WANTED, for Constructional Steel Works Drawing-office in London, TWO DRAUGHTSMEN, age 20-24. Theoretical knowledge and capable of carrying through details of Steel-framed Buildings, Roof Work, &c. State previous experience.—Address, P5190, The Engineer Office. P5190 A

WANTED, TECHNICAL ASSISTANT for Research Section, Engineering Department. Age preferably 23-25. Previous study of factory processes and some knowledge of costing and progress work desirable. State training, qualifications, and salary required.—Address, 7788, The Engineer Office. 7788 A

CIVIL ENGINEER, Westminster, REQUIRES temporarily a qualified ASSISTANT or DRAUGHTSMAN, experienced in Sewerage and Water. State age, salary and references.—Address, P5192, The Engineer Office. P5192 A

ENGINEER REQUIRED, to Take Charge of Modern Power Station in East Anglia; 3000 K.W., W.T. boilers, turbines; also Repair and Maintenance Foundry Plant. Salary £500.—Applicants should state age and enclose particulars of their qualifications and references to Box No. 2239, c/o A. J. Wilson and Co., 154, Clerkenwell-road, E.C. 1. 7789 A

ENGINEER REQUIRED for Large Rubber Manufacturing Concern (preferably with experience of the Rubber Trade), to Take Charge of Power Plant, Steam and Electric Transmission, General Upkeep and Construction of Mill Machinery and Mould Making. In replying give full particulars of experience and qualifications, and state, if any, technical training, and salary expected.—Address, 7772, The Engineer Office. 7772 A

ENGINEER WANTED for Large Industrial Company, with technical education and qualifications, experience of Mill Machinery, Construction and Maintenance and Fitting Shop Practice. Power Plant, including steam, electrical, E.H.T., D.C., and A.C. current, and Transforming Plant; Hydraulic Machinery. Able to keep plant running at full efficiency and estimate on new work.
Executive ability essential, and able to control labour. State qualifications, experience, and salary expected.—M.B.D., Register Publishing Co., Ltd., 113, Kingsway, W.C. 2. 7771 A

TECHNICAL ASSISTANT, "ENGINEER," Friday, March 3rd, No. 7565.—Advertisers wish to thank all applicants for the above POST, which has now been filled. 7775 A

TECHNICAL ASSISTANT REQUIRED in the Estimating Office of Engineering Firm in London handling heavy steam, electrical and air compressing machinery. Thorough technical training and a fair experience with steam plant calculations and lay-outs essential. A working knowledge of French or German an advantage.—Address, giving particulars of training and experience, and stating age and salary in last position, 7787, The Engineer Office. 7787 A

DRAUGHTSMAN REQUIRED; Experience in Water-tube Boiler Design and Details essential. State experience and salary required.—Address, P5182, The Engineer Office. P5182 A

SITUATIONS OPEN (continued) Page II.

SITUATIONS WANTED, Page II.

MACHINERY, &c., WANTED Page II.

FOR SALE, Pages II. and III.

AUCTIONS, Pages III. and LXXXVIII.

PREMISES TO LET OR WANTED Page III.

WORK WANTED, Page IV.

AGENCIES, Page II.

MISCELLANEOUS, Page II.

For Advertisement Rates See Page 361, col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page LXXXVII.

SITUATIONS OPEN (continued)

SALES ENGINEERS.—DISTRICT REPRESENTATIVES for North of England REQUIRED by large London company. Must have sales experience and knowledge of general engineering and textile machinery. Splendid opportunity for able men to influence business.—Write, Box 1792 Sell's Advertising Offices, Fleet-street, E.C. 4. 7815 A

REQUIRED IMMEDIATELY, EXPERIENCED DRAUGHTSMAN in Design of Ash and Coal-handling Plant and Water-tube Boilers. State experience and salary required.—Address, P5181, The Engineer Office. P5181 A

SMART JUNIOR DRAUGHTSMAN, Age 23 to 26, knowledge of all-round engineering necessary. Good opportunity for suitable applicant.—Address, stating age, experience, and salary required, 7785, The Engineer Office. 7785 A

ESTIMATING CLERK for London Manufacturer, with practical knowledge of Mechanical Engineering—Stamping and Piercing Sheet Metals.—Write, stating fully experience and salary, Box 1793, Sell's Advertising Offices, Fleet-street, E.C. 4. 7813 A

SITUATIONS WANTED

ASSISTANT DIVISIONAL LOCOMOTIVE SUPERINTENDENT, ASSISTANT SHOPS SUPERINTENDENT, or RUNNING SHED FOREMAN, home, Colonies or abroad; ex-Captain, R.E. (27), single; 4½ years' apprenticeship English railway, 5½ years' Army service, including railways, France and Russia; 14 months Latin America, running, shops, English and American practice; used to locomotives burning oil fuel; working knowledge of Spanish; good references. Available interview.

Address, P5198, The Engineer Office. P5198 B

BUYING ENGINEER.—The MANAGER of a large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 615, c/o Deacon's, Leadenhall-street, E.C. 3. 7704 B

ADVISORY POST WANTED.

ADVERTISER, M.I. Mech. E., with Exceptional commercial and manufacturing experience at home and abroad, DESIRES a POST. Has successfully filled the position of director, general manager and works manager respectively in three of the largest firms in Great Britain. Can originate and carry through complete organisation of all departments. Moderate terms and would take a small interest to qualify as director in sound undertaking.

Address, P5174, The Engineer Office. P5174 B

ENGINEER, Expert in Manufacture of Tin Boxes, canisters and bottles for preserving trade and general trade purposes, DESIRES CHANGE and Seeks Post as Manager or Foreman in factory (London or country); 25 years' experience England and abroad with machinery, old and modern, in solder and air-tight solution processes, also expert in die making of every description. Past 7 years engineer in charge large tin box factory in London. Highest credentials for character and ability. Free in April.—Address, P5200, The Engineer Office. P5200 B

ENGINEER (23) DESIRES EXPERIENCE; Public school education, indentured app. mech. engineers, now expired; 3½ yrs. shops, 2½ yrs. D.O. London district preferred.—Address, P5202, The Engineer Office. P5202 B

ENGINEER (25, Single, N.U.), 2 Years D.O., 3 in shops of gen. mech. engineers, also 16 months crude oil engine building, DESIRES POSITION, Assistant on Plant or similar work, home or abroad. Good refs.—F. PEARSONS, Belchamp Walter, Sudbury, Suffolk. P5206 B

ENGINEER (32), Mechanical, Locomotive, Rolling stock, thoroughly experienced works manager and organisation, two years' Indian experience, DESIRES Works Manager or District Representative APPOINTMENT.—Address, P5183, The Engineer Office. P5183 B

ENGINEER, Young, at Present with London Firm of consulting engineers, DESIRES CHANGE; first-class industrial works experience, including automatic electric control and general steel works practice, also handling men on large contracts. Would consider good agency or post where personal initiative would be valued. Present residence South Yorkshire; willing to change. State approximate salary, &c.—Address, P5196, The Engineer Office. P5196 B

MECHANICAL ENGINEER (23), Articled, Sound technical training, 4 years' experience of works organisation and management, 6 years designer and chief draughtsman, shortly disengaged, REQUIRES responsible POSITION in progressive firm. Willing to invest moderate capital.—Address, P5102, The Engineer Office. P5102 B

MECHANICAL ENGINEER, Late Manager of Small works, SEEKS any responsible POST, where 30 years' good all-round general experience (works and office) is of value.—SNOAD, 36, York-road, Hitchin. P5204 B

POST REQUIRED as Supt. or Asst. Manager. Keen disciplinarian, wide experience production engineering, machine tools, printing machinery, repetition work and general engineering. Successful organiser. Invest if desired or would consider partnership in small firm. Knowledge of costing, estimating, &c.—Address, P5189, The Engineer Office. P5189 B

PROGRESS—SUPERVISION Chasers and Component Stores. Production records. Southern district preferred.—WOOLLETT, 21, Kent-road, Dartford. P5188 B

WELL-KNOWN REPRESENTATIVE, of Good personality and ability, possessing considerable experience in elevating and conveying machinery, heavy quarry and mining machinery, steel and iron castings, DESIRES to HEAR from first-class FIRM requiring REPRESENTATION. Keen, progressive business man. Would consider commercial or sales managership. B.O.T. Cert., A.M.I. Mech. E.—Address, P5147, The Engineer Office. P5147 B

DRAUGHTSMAN, for 15 Years Engaged in technical matters, carriage building design and mechanical structures, hand cranes, plant work, aircraft machine design, and general detail work of production, SEEKS POST. Age 30.

Address, P5203, The Engineer Office. P5203 B

MECHANICAL DRAUGHTSMAN, with Wide Experience in the design and lay-out of various industrial plants, power station design, and general engineering, DESIRES SITUATION; London or South Coast.—Address, P5187, The Engineer Office. P5187 B

MECHANICAL DRAUGHTSMAN REQUIRES CHANGE of APPOINTMENT (London district). Sound technical knowledge, 5 years shops, 3 years D.O.; age 25. Moderate salary.—Address, P5194, The Engineer Office. P5194 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.
46, Watling Street, London, E.C. 4.

Established seventy years.

ENGINEER or GENTLEMAN with Capital REQUIRED to join another to form syndicate to develop several valuable patents; sound investment and good returns.—Address, P5136, The Engineer Office P5136 C

AGENCIES

A WELL-ESTABLISHED FIRM of ENGINEERS and FOUNDERS in Natal are DESIROUS of OPENING a DEPARTMENT to deal in Engineers' Specialities, Mill and Engine Stores and Supplies, Industrial Machinery, &c., and would be pleased to take up Sole Selling Agencies for suitable lines, carrying consignment stocks. Efficient staff and business organisation, ample stores and capacity, any financial guarantees required.—Apply, PERCY WILDE, Finsbury Pavement House, London, E.C. 2. P5113 D

AGENTS WANTED for Sale of Patent Keyless Padlock.—Write for particulars and appointment, M. CURZON, 272, Pentonville-road, King's Cross, N. 7795 D

ENGINEERS' MERCHANTS, Having Been Established some considerable time, are OPEN to ACCEPT really first-class AGENCIES. Only firms of repute need correspond.—M.U.T.A., 17, Farringdon-street, London, E.C. 4. P5201 D

LONDON REPRESENTATIVE. — ENGINEER (Mech.), public school education, good personality, enthusiastic and determined salesman, WISHES to ACT for First-class FIRM; 12 years' outside and office experience. Splendid credentials.—Address, P5191, The Engineer Office. P5191 D

EDUCATIONAL

CIVIL ENGINEER, Westminster, has a VACANCY for a PUPIL; waterworks, sewerage, &c.—Address, P5193, The Engineer Office. P5193 E

CORRESPONDENCE COURSES for B.Sc., Inst.C.E., I. Mech. E., and all ENGINEERING EXAMINATIONS. Special Courses and Single Subjects. Personal Tuition.—Mr. TREVOR W. PHILLIPS, B.Sc. (Hons.), Assoc. M. Inst. C.E., M.R.S.I., &c., 8-10, Trafford Chambers, 58, South John-street, Liverpool. Ex.

INST. C.E. Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS. — Mr. G. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Courses can be commenced at any time.—39, Victoria-street, Westminster, S.W. Telephone No., Victoria 4780. Ex.

LEARN SURVEYING AND LEVELLING.—Thorough practical instruction given by an expert. —Address, E. MOUL (late L.S.W. and S.P.D. Rlys.), Hollybank, Woking. P5210 E

TUITION BY POST.—Inst. C.E. and I. Mech. E. Enrol now for next Exams.; 100 per cent. passes last examination. Estab. 1876.—PENNINGTONS, University Tutors 254, Oxford-road, Manchester. Ex.

PATENTS

SAFETY VALVES. — The PROPRIETORS of PATENT No. 105,335, for "Improvements in Safety Valves," are DESIROUS of ENTERING into ARRANGEMENTS with manufacturers or other interested parties for the MANUFACTURE and EXPLOITATION of the invention in the United Kingdom on reasonable terms.—For particulars apply to FELL and JAMES, 11, Queen Victoria-street, London, E.C. 4. 7814 H

THE PROPRIETOR of BRITISH PATENT No. 168,875, dated February 9, 1918, relating to "An Improved Refrigerant," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 7743 H

THE PROPRIETORS of PATENT No. 101,662, "Floating Wedge Lock Nuts," are DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.

All communications should be addressed in the first instance to J. E. EVANS-JACKSON and CO., Bath House, 57/60, Holborn-viaduct, London, E.C. 1. P5101 H

THE PROPRIETOR of BRITISH PATENTS Nos. 9806/13 and 9807/13, both dated April 26, 1913, relating to "Roofing," is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCES or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical workings in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 7790 H

THE PROPRIETOR of BRITISH PATENT No. 18,794/13, dated April 18, 1913, relating to "Improvements in Shock Diffusers for Vehicles," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7807 H

THE PROPRIETOR of BRITISH PATENT No. 129,744, dated April 3, 1918, relating to "Improvements in or relating to Tyre and like Inflating Valves," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7808 H

THE PROPRIETOR of BRITISH PATENT No. 128,706, dated June 14, 1918, relating to "Improvements in Clutch and Brake Friction Facing and in the Process of Making the same," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7809 H

PATENTS.—"IMPROVEMENTS IN CUTTING-OFF LATHES AND THE LIKE."

THE PROPRIETORS of MAFFEI TWO BRITISH PATENTS Nos. 24,519/12 of 1912 and 103,303 are DESIROUS of LICENSING them to British Manufacturers on reasonable terms to ensure their manufacture and development or of SELLING the PATENTS outright.—For full information address inquiries to W. P. THOMPSON and CO., Chartered Patent Agents, 12, Church-street, Liverpool. P5209 H

MISCELLANEOUS

WANTED, ENGINEERS' PATTERNMAKING. L. HOWARTH, 12, Skipton-street, Harrogate. Estimates free. P5104 I

A SOUND INVESTMENT WITH OCCUPATION.—FRUIT GROWING under glass in England. Actual results available for inquirers. Capital from £3000.—HORTUS, Limited, Eldon-street House, London, E.C. 2. P5126 I

SIX New VOLUMES, Metallurgy Course, Comprising nickel, aluminium, cyaniding, copper, zinc, coal, electro-metallurgy, hyposulphite, lixiviation, ore dressing, treating ores, hydraulics, chemistry, assaying, mineralogy, engines, boilers, blow-piping, mathematics, mechanics, drawing.—119, Green-lane, Walsall, Staff. P5205 I

TO CONTRACTORS AND OTHERS.—GENTLEMEN (Two), widely experienced in reinforced concrete — designing and construction, SEEK ARRANGEMENT with established firm with a view to commencing or developing reinforced concrete section. Financial interest would be taken and specialities introduced.—Address, P5207, The Engineer Office. P5207 I

TO ENGINEERS.—Old-established Firm in Westminster, with extensive foreign and colonial experience, are inclined to retire from business and would LET their OFFICES or entertain MANAGING and FINANCING any good SPECIALITY.—Address, P5186, The Engineer Office. P5186 I

TRANSLATIONS (French, German and Dutch). Accuracy and prompt service.—R. SWIFT, 50, St. Ross-street, Moss Side, Manchester. Many years experience in engineering trade. P5001 I

MACHINERY, &c., WANTED

WANTED, a Good Second-hand Modern S.S.S. GAP HEAVY LATHE, to swing about 4ft. diam., 12in. centres, and 10ft. between centres, with mandrel about 5½in. diameter minimum.—State lowest price and full particulars to H. BROWN and CO., Princes-street, Bristol. 7796 F

WANTED, AIR RECEIVER, About 14ft. by 5ft.—for 100 lb. pressure. State price and where may be seen.—SAMUEL BUTLER and CO., Ltd., Albion Works, Stanningley. 7823 F

WANTED, LANCASHIRE STEAM BOILERS.—ONE, 30ft. by 8ft. by 120 lb. ONE, 27ft. by 7ft. or 7ft. 6in. by 120 lb. Address full particulars, giving age, maker, and where to be seen, 7829, The Engineer Office. 7829 F

WANTED, Second-hand Blackstone, Ruston-Hornsby's OIL and CRUDE OIL ENGINES, 8 to 30 horse-power; DISINTEGRATORS, LATHES. —CHAMANAL, 250, Brecknock-road, London, N. 19. P5190 F

WANTED, Second-hand DRAUGHTING MACHINE, full size; also few VERNIER CALIPERS, 12in.-36in., and MICROMETERS, 1in.-6in.—Address, 7798, The Engineer Office. 7798 F

WANTED, SUCTION GAS ENGINE, Direct Coupled to ELECTRIC GENERATOR, 2-phase, 200 volts, 50 periods, output 100 to 200 B.H.P. Must be in perfect condition, with gas plant, starter, &c.

Also MAIN SWITCH and DISTRIBUTION BOARD. Address full particulars and price to P5148, The Engineer Office. P5148 F

WANTED, THREE NAILING MACHINES, by well-known makers, and in perfect condition.—T. H. HARRIS and SONS, Ltd., 22, Marsh Gate-lane, Stratford, E. 15. 7780 F

SHUNTING LOCO., 13/14in. Cylinders, 150 lb., Four wheel coupled, 5ft. wheel base.—Address full particulars, 7797, The Engineer Office. 7797 F

FOR SALE

A TIME RECORDER, as New, Guaranteed. Latest model. What offers?—A. F. PELLEY, 149, Farringdon-road, E.C. 1. Ex.

BOILERS FOR SALE.

ONE Lancashire, 28ft. by 7ft. 2in., for 100 lb. pressure.
One Cornish, 20ft. by 6ft., for 100 lb. pressure.
One Cochran Vertical, 14ft. by 6ft. 6in. for 100 lb. pressure.
One Cochran Type, 15ft. by 7ft. 6in., for 100 lb. pressure.
One Hindley Tubular, 12ft. by 6ft. 6in., for 100 lb. pressure.
Two Ditto, 11ft. 6in. by 6ft., for 140 lb. pressure.
One Cochran, 10ft. by 4ft. 6in., for 90 lb. pressure.
One Vertical Tubular, 7ft. 9in. by 3ft. 3in., for 100 lb. pressure.
One Vertical Tubular, 16ft. by 4ft., for 70 lb. pressure.
One Vertical Cross Tube, 10ft. by 4ft., for 60 lb. pressure.
One Vertical Cross Tube, 8ft. by 3ft., for 60 lb. pressure.
Two Ditto, 4ft. by 2ft. 3in., for 80 lb. pressure.
Six Ditto, 4ft. 6in. by 2ft. 1in., for 80 lb. pressure (new).
One 40 H.P. Loco. Type, 160 lb. pressure.
Two 14 H.P. Loco. Type, 150 lb. pressure.
One 10 H.P. Loco. Type, 100 lb. pressure.
One 12 H.P. Loco. Type, 80 lb. pressure.
GEO. COHEN SONS and CO., 600, Commercial-road East, London, E. 14. Ex.

BORING MILL, NEW, 40in. TABLE, SINGLE PULLEY DRIVE, LATEST TYPE; 6400. MARTIN BROS. (MACHINERY), LTD., 33-35, BRIDGE-STREET, MANCHESTER. 'PHONE, CITY 3206 (4 LINES). TELEGRAMS, "PEDESTAL." 7824 G

BORING MILL, 80in., LATEST DESIGN, WEIGHS 20 TONS, ALL-GEARED DRIVE, CAPACITY 6ft. 6in., BRAND NEW, TWO HEADS. BEAUTIFUL TOOL. BELOW PRE-WAR PRICE TO CLEAR. MARTIN BROS. (MACHINERY), LTD., 33-35, BRIDGE-STREET, MANCHESTER. 7825 G

BRINELL TESTING MACHINE, by Derihon, 3000 Kilogrammes deadweight type. Illustration and full details upon application.—JONES, 18/20, Church-street, Islington, N. 1. P5184 G

COCHRAN VERTICAL MULTITUBULAR BOILER FOR SALE (NEW), Class B, (Marine Type), 14ft. by 6ft. 6in., 100 lb. with Lloyd's certificate.—Address, 7094, The Engineer Office. 7094 G

DIESEL ENGINES, Six-cylinder, Two and Four-stroke, 850, 1800, 1200 H.P. Excellent condition. DYNAMOS for above, 250 or 300 volts D.C. Immediate delivery and low price.

Also TWO 500 K.W. PARSONS TURBINE SETS, 250 or 500 volts D.C., with condenser and spare armature.

ELECTRICALLY DRIVEN AIR COMPRESSORS, 250 volts D.C., pressures 1500 to 2000 lb. per sq. inch. JENNINGS, West Walls, Newcastle-on-Tyne. Ex.

FOR SALE, About 70 TONS of OLD SACKING; quotation required f.o.b. or f.o.r. Magheramorne.—Apply, BRITISH PORTLAND CEMENT MANFRS., Ltd., Magheramorne, Co. Antrim. P5105 G

FOR SALE, ASTER PETROL-PARAFFIN SET.—1 Twin-cylinder 8.5 H.W. Combined Generator Set, 100 to 160 volt, with extra compounding on generator for direct running on light. Can be seen working under load by appointment.—Apply, F. P. SIBLEY, Church Mount, Sutton-on-Hull, E. Yorks. 7799 G

FOR SALE

FOR SALE, "ECONOMIC" BOILERS (4), Davey-Paxman, 12ft. by 8ft. dia., 160 lb. press., 5000 lb. evaporation, mountings and fittings; immediate delivery.—T. WILLIAMS and SONS, South Bermondsey Station, London, S.E. 16. Hop 834. 7643 G

FOR SALE, ELECTRIC GENERATING PLANT, in good working order, lying in London, comprising:—Four 420/440 volts Lancashire Dynamos driven by Four "Bellis and Morcom" Engines, 2 Balancing Sets, 20 H.P. "Bellis" Oil Engine, 3-Ton Overhead Travelling Crane.—Particulars of BORNE and CO., Auctioneers, Crown-court, Cheapside, E.C. 2. 7776 G

FOR SALE, First Quality SECOND-HAND SLEEPERS; main line, uncreosoted; suit for sidings, cart roads, &c.—E. H. NEAL and CO., 52, The Broadway, Ealing, W. 5. Telephone, Ealing 1764. 7636 G

FOR SALE, LEAD-LINED WOODEN VATS, Rectangular and Circular, 16 Vats, capacity from 3500 to 6000 galls.; 10 Vats, capacity from 150 to 550 galls.

Also STEAM LOCO. CRANE, 22ft. jib.

TWO 5-Ton OVERHEAD ELECTRIC TRAVELLING CRANES, 42ft. and 51ft. 3in. spans.

ELECTRICAL PLANT, all descriptions. Also JOISTS, CHANNELS, ANGLES, &c.—JOSEPH OXLEY (Sheffield), Ltd., Norfolk-street, Sheffield. 7625 G

PETROL LOCOMOTIVES.—FOR SALE, 2ft. gauge, 40 Horse-power PETROL LOCOMOTIVE, wheel base 4ft., latest design; excellent powerful machines.—Address, 7711, The Engineer Office. 7711 G

FOR SALE, ONE New Hayward-Tyler Horizontal Compound Duplex STEAM PUMP, special design, capable of raising 10,000 to 12,000 gallons of water per hour against a maximum pressure of 220 lb. per sq. in., with a working steam pressure of 100 lb. per sq. in. No reasonable offer refused, even if much less than cost price.—Apply, Engineer, BASS and CO., Ltd., Burton-on-Trent. 7710 G

FOR SALE, PLANING MACHINE, Earnshaw, Take work 14ft. by 5ft. by 4ft. high, rack-driven table 15ft. long, two tool-boxes on cross slide, strong gearing; low price.—J. T. WILLIAMS and SONS, South Bermondsey Station, London, S.E. 16. Hop 834. 7647 G

FOR SALE, THEODOLITES, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road). Ex.

FOR SALE, LEVELS, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road). Ex.

FOR SALE, THREE 50 K.W. STEAM GENERATING SETS, 110 volts, 450 r.p.m. Price £155 each. Fixed working, Liverpool.—WILLIAMS and SONS, 37, Queen Victoria-street, London. 7817 G

FOR SALE, TWO HORIZONTAL CROSS COMPOUND CONDENSING DROP VALVE ENGINES; 250 H.P., 110 r.p.m., 150/160 lb. steam pressure, in good condition.—Can be seen on load by arrangement with CROMPTON and CO., Ltd., Chelmsford. 7821 G

FOR SALE, TWO Horizontal Davey-Paxman Steam-driven AIR COMPRESSORS, steam cyls. 12in. and 22½in. by 22in. stroke, air cyls. 24in. dia., capacity 900 cub. ft. Fixed working, Liverpool. Low price for immediate clearance.—WILLIAMS and SONS, 37, Queen Victoria-street, London. 7818 G

FOR SALE, VERT. DOUBLE-HEADED BORING MILL, Hulse, revolving table 4ft. dia., self-acting, strong gearing, driving pulleys, &c.; low price, immediate delivery.—J. T. WILLIAMS and SONS, South Bermondsey Station, London, S.E. 16. Hop 834. 7646 G

FOR SALE, VERT. HIGH-SPEED COMPOUND STEAM ENGINES (2), Hellies and Morcom, about 300 H.P. each, suitable for direct coupling; immediate delivery; inspect.—J. T. WILLIAMS and SONS, South Bermondsey Station, London, S.E. 16. Hop 834. 7640 G

FOR SALE, WINCHES

PAIR, 7in. cyls. by 12in., Clarke-Chapman.

PAIR, 6in. cyls. by 16in., Clarke-Chapman.

PAIR, 9in. cyls. by 12in., PIPING WINCH, two drums, boiler 11ft. 6in. by 5ft. 3in., for 120 lb. steam, and several others.

A. UNDERWOOD, 3, Queen-street, E.C. 4. 7802 G

FOR SALE.—1 Richards Second-hand Screw-driven SIDE PLANING MACHINE, to plane 6ft. long by 15ft. wide, with two tables, in excellent condition.

1 New Archdale High-speed All-gear VERTICAL MILLING MACHINE, with self-acting circular table, self-acting longitudinal traverse 24in., transverse traverse 10in., vertical adjustment 16in., plain table 24in. by 11in., including bevels, fittings, arbors, &c. Low price.—Apply, MITCHELL, GRAHAM and SON, Ltd., 56, Buccleuch-street, Edinburgh. P5208 G

FOR SALE, 3-Ton LOCO. CRANE, by Wilson, 8ins under stichm, 22ft. jib.—A. UNDERWOOD, 3, Queen-street, E.C. 4. 7801 G

FOR SALE.—16 H.P. PORTABLE ENGINE, by Marshall, 80 lb. steam, iron wheels, iron fore-carriage.

20 H.P., by Marshall.

20 H.P., by Foster, with reversing gear.

A. UNDERWOOD, 3, Queen-street, E.C. 7802 G

FOR SALE.—

90 TONS of 15in. C.I. FLANGED PIPES, drilled to B.S.T. No. 2, lengths from 3ft. to 12ft.

14 TONS of 6in. C.I. FLANGED PIPES, drilled to B.S.T. No. 2, 9ft. and 6ft. lengths.

1 90 N.H.P. LOCO. TYPE BOILER, by Davey, Paxman, re-insure 150 lb. pressure.

10ft. 6in. by 4ft. 9in. Spencer-Hopwood Patent VERTICAL BOILER, re-insure 100 lb. pressure.

STANLEY ENGINEERING CO., Bath. Ex

FOR SALE, 140 H.P. Davey-Paxman Cross Compound HORIZONTAL ENGINE, cyls. 13in. and 22½in. by 33in. stroke, 160 lb. steam pressure. Now fixed.—WILLIAMS and SONS, 37, Queen Victoria-street, London. 7815 G

FOR SALE.—

TWO HEAVY RING-OILING BEARINGS, 15in. by 15in.

Address, 7706, The Engineer Office. 7706 G

GOVERNMENT STORES AT SLUMP PRICES.—Black Corrugated Sheets, 6ft. and 7ft. lengths, 2s per sheet.

500 Tons Granite Setts.	500 Tons Hard Core.
English Oak and Elm Logs cut into Planks.	
Decauville Railway.	Foden Steam Wagons.
Bar Steel.	Trailers.
	Motor Wagons.
Government Huts of all sizes.	
Girders.	Bolts.
Roof Trusses, 30ft. span.	Nuts.
Angle Iron.	Nails.
Stanchions.	Every description of
Expanded Metal.	Building Material.
Roofing Felt.	Electrical Lighting.
Generating Sets.	

Apply, PHILLIPS, MILLS and CO., Ltd., Battersea Wharf, Battersea, S.W. 11. Telephone 7804 G

For continuation of For Sale Advertisements, see page iii.

Developments in Power Station Design.

No. XXVI.*

MUCH attention has been paid during recent years to the design of condensers and their auxiliaries, for it is common knowledge that one of the most important things to be aimed at in power stations equipped with steam turbines is a high vacuum. A great amount of experimental work has been carried out on condensing plant with a view to reducing the size and increasing the efficiency, but we propose to deal with the construction and operation of condensers and their auxiliaries rather than the research work that has been undertaken in connection with their development. Surface condensers should be so designed that the whole of the cooling surface is uniformly effective, whilst the quantity and velocity of the water must be such as to give the highest transmission rates. A slight increase in vacuum gives rise to a great increase in the volume of the steam to be condensed, and the tube surface should be arranged to offer the least resistance to the passage of the vapour through the condenser.

The advantage of dealing with the air and condensate separately has long been recognised, and steam jet ejectors for removing the air and other non-condensible gases are fitted to the Weir and other surface condensers. A two-stage Weir ejector of this type, together with an inter-condenser, is shown in Fig. 128. These ejectors, which will be dealt with more fully later, are supplied with steam at a pressure of 150 lb. per square inch, but they will also operate satisfactorily at higher pressures, and they are claimed to give the highest possible vacuum and to occupy a small amount of space. In order to prevent trouble arising as the result of the nozzles becoming choked by dirt in the pipes, a strainer is connected in the steam inlet pipe, but even if the strainer fails to collect all the dirt, the steam jets can easily be removed and cleaned.

A Weir water extraction pump as employed in conjunction with the firm's condensers fitted with these air ejectors is shown in Fig. 129. These pumps can be driven by a steam turbine or an electric motor, but a turbine offers the advantage that the exhaust steam can be utilised for heating the feed water. The turbine-driven pump runs at a comparatively low speed, namely, from 1750–3000 revolutions per minute, and the turbine has one pressure and several velocity stages. The turbine is fitted with a controlling governor, which ensures that the speed variation does not exceed 5 per cent. between no load and full load, whilst an emergency governor shuts down the set completely in the event of the speed of the machine racing as a result of the controlling governor failing to act with a sudden reduction in load, and a consequent rise in speed above the safe limit. The pump is fitted with roller bearings and a ball thrust of substantial design. To facilitate dismantling and overhauling the pump, the case is divided. Motor-driven extraction pumps are generally of the horizontal pattern, and have two or three stages.

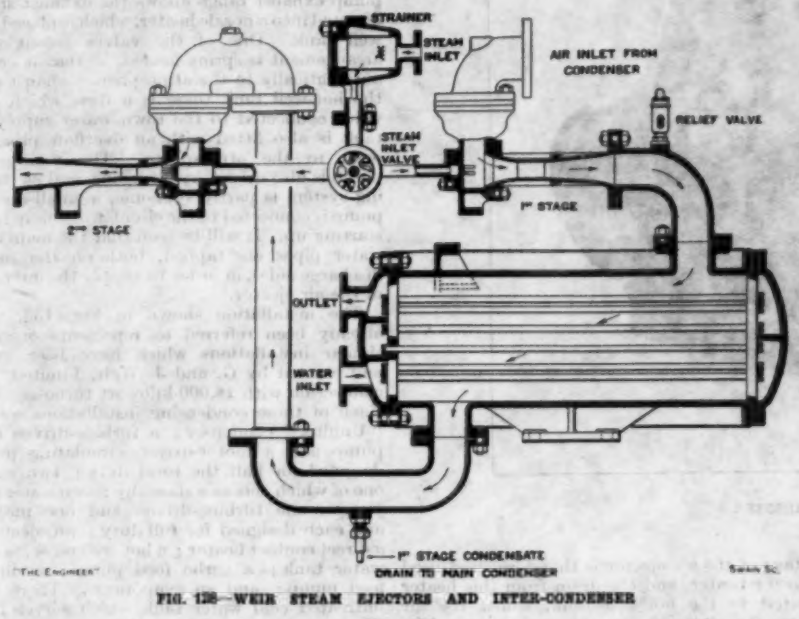


FIG. 128—WEIR STEAM EJECTORS AND INTER-CONDENSER

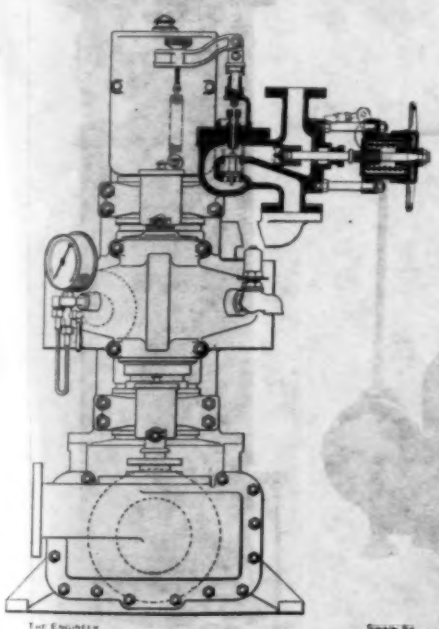


FIG. 129—WEIR WATER EXTRACTION PUMP

The Weir circulating pumps are also made in the vertical or horizontal types. Horizontal circulating pumps can either be driven by a turbine or an electric motor, according to requirements, but the vertical pump is generally driven by a motor, as the turbine drive introduces certain difficulties. The type of pump used depends upon the position of the circulating water supply system. When a culvert is provided below the station, the vertical type of pump is most suitable, but in places where the water is carried to the pump suction through pipes from a river or cooling pond, the horizontal type of pump is usually installed. A Weir turbine-driven circulating pump is shown in Fig. 130. The turbine is a three-stage pressure-compounded machine, and it drives a twin impeller type centrifugal pump, which is mounted on the same shaft as the turbine rotor. Emergency and ordinary controlling governors are fitted to the turbine.

Considerable attention is being paid at the present time to the purification of feed water. No portion of the steam side of an electric generating station escapes the bad effects of impure boiler feed, although boiler tubes, turbine blading, governor valves and steam valves in general are the parts that are usually most affected. For many years the practice of using distilled water as a feed make-up on naval vessels has been adopted with highly satisfactory results, and the scheme is now steadily gaining favour in power stations. Although it may appear at first sight that the practice of using distilled make-up water is expensive, it is claimed by those who are putting evaporators on the market for central station use that such is not the case. The trend of modern power station design has been for a long time past to decrease the amount of working fluid per horse-power developed, and there are also now fewer glands and less loss of steam than there was in the earlier central stations.

Naturally, the best method of installing an evaporator varies with the general nature of the plant, but the scheme shown in Fig. 135 has been found to be suitable in a great many instances. Boiler steam or steam from the main turbine at a pressure of about 100 lb. per square inch is conveyed to the evaporator coils through a valve which is controlled by a float in the feed tank. The vapour from the evaporator passes into the auxiliary exhaust range, which receives the exhaust from all the steam-driven auxiliary machinery. This exhaust range is connected to a feed-water heater, and also to the low-pressure stage of the main turbine. The drain from the coils of the evaporator is led to the feed or hot well tank. As long as the feed can condense all the exhaust from the auxiliaries, no thermal loss is incurred, and when the quantity of exhaust steam is in excess of that which can be absorbed by the feed water, the excess is supplied automatically to the low-pressure stages of the turbine, where a large proportion of its energy is recovered. The evaporator itself, which is shown in Fig. 133, is constructed on the same principle as the Weir marine evaporator.

The Weir turbo feed pump shown in Fig. 132 is designed to discharge against the highest boiler pressures, and, subject to temperature conditions, is capable of lifting the water from the maximum possible depth. The pump is adapted to work with the usual types of feed regulators and in conjunction with ordinary reciprocating feed pumps. As the exhaust steam contains no oily residue, it may be used for heating the feed water by direct contact,

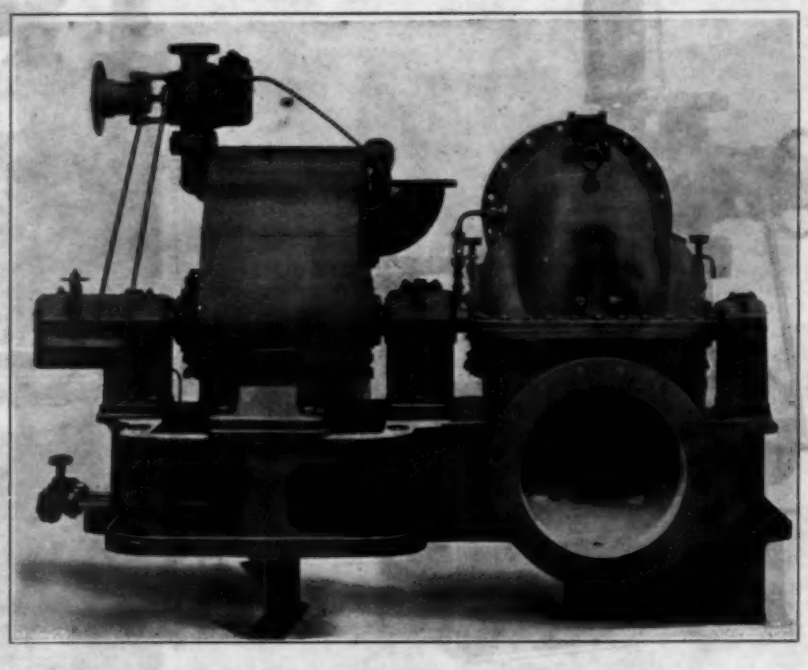


FIG. 130—WEIR TURBINE-DRIVEN CIRCULATING PUMP

with the result that all the heat in the steam can be utilised. The turbine has one pressure and several velocity stages, whilst the pump is a single-stage centrifugal machine. The turbine casing and bearings are divided horizontally, and the lower portions are integral with the general framework of the base, which is extended at one end to form a flange to which the pump casing is rigidly secured. The impeller of the pump is carried on the overhanging end of the turbine shaft, and the use of a third bearing is avoided. The pump is automatic in action, is claimed to be noiseless and vibrationless, and to occupy very little space for its output.

In the closed circuit feed system which has recently

* No. XXV. appeared March 17th.

been put upon the market by G. and J. Weir, Limited, of Cathcart, Glasgow, and which is at present being installed in various power stations in different parts of the country, the foregoing devices have been embodied, and the drawing—Fig. 136—shows a typical example of the most recent arrangement which has just been put into service. The "Uniflux" condensers

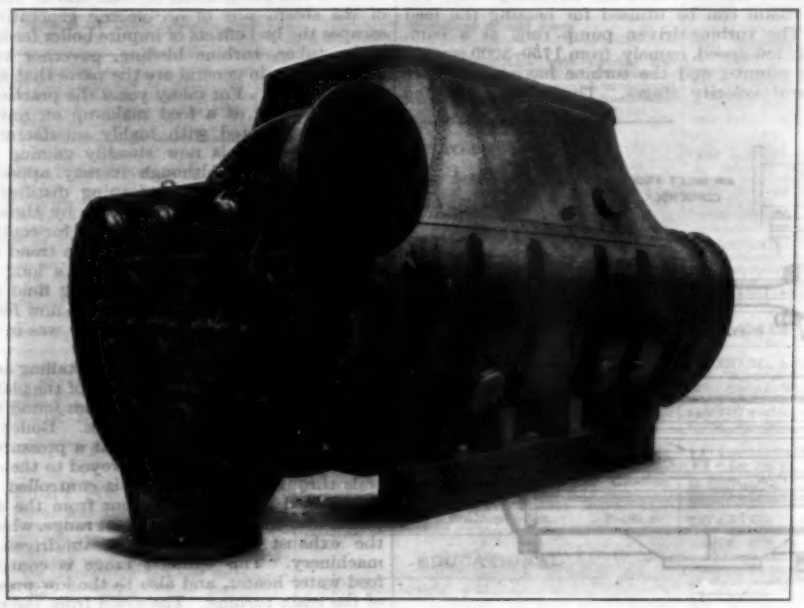


FIG. 131—WEIR UNIFLUX CONDENSER

—see Fig. 131—have been designed to ensure that the steam passes over every part of each tube at a uniform velocity, and in practically a direct line from the turbine exhaust flange to the vapour and air outlets. There are no baffle plates or partitions to interfere with the flow of steam, and the high efficiency of the condenser makes it possible to obtain a high vacuum. Moreover, the design of the condensers enables the water to pass through the tubes at a high velocity, and it is claimed that no stagnation occurs on the tubes. In some condensers, it is maintained, some of the tubes are exposed to practically stagnant circulating water, which assists in the formation of scale with the result that the efficiency of the condenser is reduced.

Two systems of pipe connections are shown in Fig. 136, and are known as the "closed" and "open" systems, the latter being shown by the dotted lines. When running on the closed system, air and other non-condensible gases are drawn from the condensers by a Weir steam jet air ejector, as shown in Fig. 128, and is discharged into an ejector heater and then into the main heater, the heat from the air ejectors being transmitted to the condensate discharged by the water extraction pump. The steam used in the second stage of the air ejector is therefore condensed in the ejector heater, and the drain from this heater is connected to the hot-well tank, whilst the air escapes to the atmospheric exhaust range. The main heater, which is of the multi-flow type and similar to that shown in Fig. 134, is placed on top of the hot-well tank, and is capable of condensing the whole of the exhaust steam from the turbo-circulating water pump, water extraction and feed pumps, and heats the feed water to a temperature of about 200 deg. Fah. The feed pumps draw their water direct from the main heater and discharge it into the boilers, whilst the heater drains into the hot-well tank. In the event of the feed-water supply being in excess of the demand, the pressure in the feed suction pipe rises and opens a spring-loaded overflow valve, which allows the feed water to pass into the hot-well tank. If the main turbine slows down or stops altogether, the water level in the water-extraction pump suction falls, and causes a dual control float to fall and open a relay valve on the pressure pipe connected between the dual valve and the water extraction pump discharge, thus lowering the pressure in the control cylinder of the supplementary feed valve, which thereupon opens and enables the feed supply to be kept up from the hot-well tank and de-aerated in the condenser before passing into the feed circuit.

When the equipment is worked in accordance with the open circuit system, the water extraction pump discharge passes, after it leaves the ejector heater, into the hot-well tank from which the feed pumps draw their water. A double exhaust valve on the feed pump exhaust range allows the exhaust steam to be directed into a nozzle heater, which is placed in the hot-well tank. One of the valves belonging to this arrangement is spring-loaded, so that it can exhaust automatically to the atmospheric exhaust range. In the hot-well tank there is a float which controls a valve connected to the town water supply, and the tank is also fitted with an overflow pipe, which is open to the atmosphere. The main circulating pump is also driven by a turbine, and as the circulating system is partly syphonic, a small air exhauster pump is connected to the circulating pump to facilitate starting up. It will be seen that the main circulating water pipes are tapped, both on the suction and discharge sides, in order to supply the inter-condenser of the air ejector.

The installation shown in Fig. 135, which has already been referred to, represents one of several similar installations which have been constructed and erected by G. and J. Weir, Limited, for use in connection with 18,000-kilowatt turbo-generator sets. Each of these condensing installations consists of a "Uniflux" condenser; a turbine-driven circulating pump and a motor-driven circulating pump, each designed for half the total duty; two air ejectors, one of which acts as a stand-by; two water extraction pumps, one turbine-driven and one motor-driven, and each designed for full duty; an ejector heater; a direct contact heater; a hot-well tank; a condensed water tank; a turbo feed pump; a direct-acting feed pump; and an evaporator. There is also an untreated cold water tank which serves for two of these condensing plants. All these units, with the exception of the motor-driven pumps, which were made by Drysdale and Co., Limited, of Yoker, Glasgow, were supplied by G. and J. Weir, Limited. The condenser is designed to maintain a vacuum at the main turbine exhaust flange of 28in. when supplied with circulating water having an inlet temperature of 75 deg. Fah. The condensate is drawn from the condenser by the turbine-driven water extraction pump, or, alternately, by the motor-driven pump, and is first passed through the ejector heater and then through the direct contact heater to the hot-well. In the extraction pump discharge pipe there is a "Venturi" meter, which registers both the rate of flow and the quantity of water passed. Air and

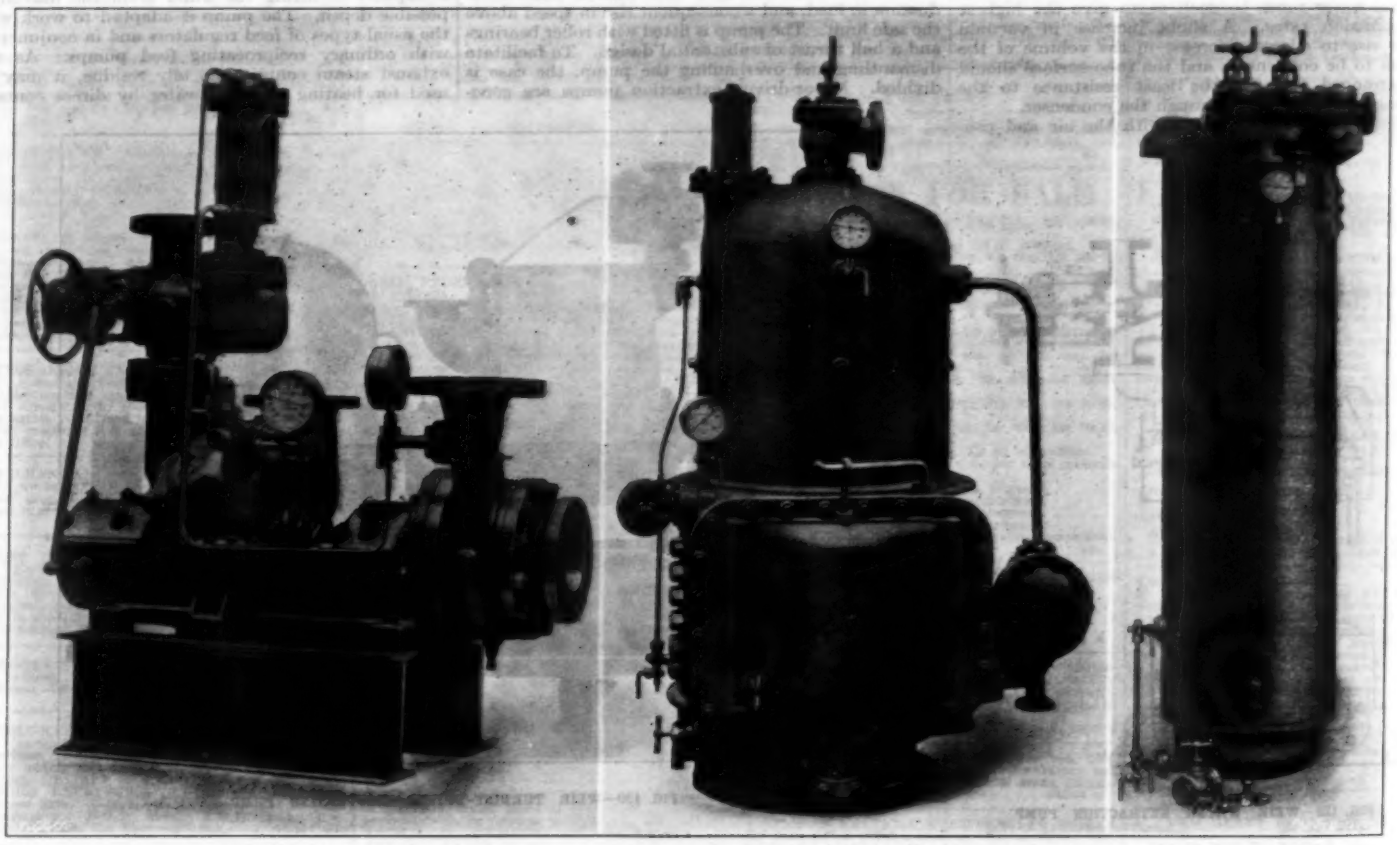


FIG. 132—WEIR TURBO FEED PUMP

FIG. 133—EVAPORATOR

FIG. 134—HEATER

vapour are drawn from the condenser by the steam jet air ejector, and they are discharged into the ejector heater, where the heat is transmitted to the water discharged by the extraction pump, the heater draining into the untreated cold water tank, whilst the air escapes into the atmospheric exhaust range.

The direct contact heater is supplied with steam from the exhaust range, to which the exhausts of the turbine-driven circulating, extraction and feed pumps are connected, and into which the vapour from the evaporator is also led. In the event of the supply of exhaust steam being sufficient to cause the temperature of the feed water in the hot-well to exceed the limit demanded by the economisers, namely, 180 deg. Fah., the excess steam can be passed into the condensers through a special valve, which is balanced. Arrangements have also been made to allow the exhaust steam from the turbine-driven circulating and extraction pumps to be exhausted into the low-pressure stage of the main turbine when it is working on overload and when, with the evaporator in operation, there is more exhaust steam than is necessary for feed-water heating. The hot-well tank contains two floats. One of them operates when the water falls below the normal working level and opens a valve which in its turn admits steam, drawn from a low-pressure stage of the main turbine, to the evaporator. The vapour passes to the direct contact heater, where it is condensed, and it then passes to the hot-well tank. The second float operates in the event of the water level continuing to fall during the period when the evaporator is being put into service, and has not reached its normal output, or when the feed pumps are drawing more water than is being discharged by the water extraction pump. This float opens a valve which admits water to the hot-well tank from the condensed water tank. The condensed water tank is also fitted with a float, and when the water level falls it opens a valve which admits saturated steam to the evaporator, and at the same time opens a valve which supplies water to this tank through a calibrated diaphragm fitted on the extraction pump discharge range. The vapour from the evaporator, which makes up the feed water in the manner previously described, can also be led to the condenser, where it is condensed, the condensate being afterwards dealt with by the water extraction pump, and returned to the tanks. The feed pumps draw their water direct from the hot-well tank, or, alternatively, from the condensed water tanks through the normal or emergency feed-water suction mains, and supply the water direct to the boilers.

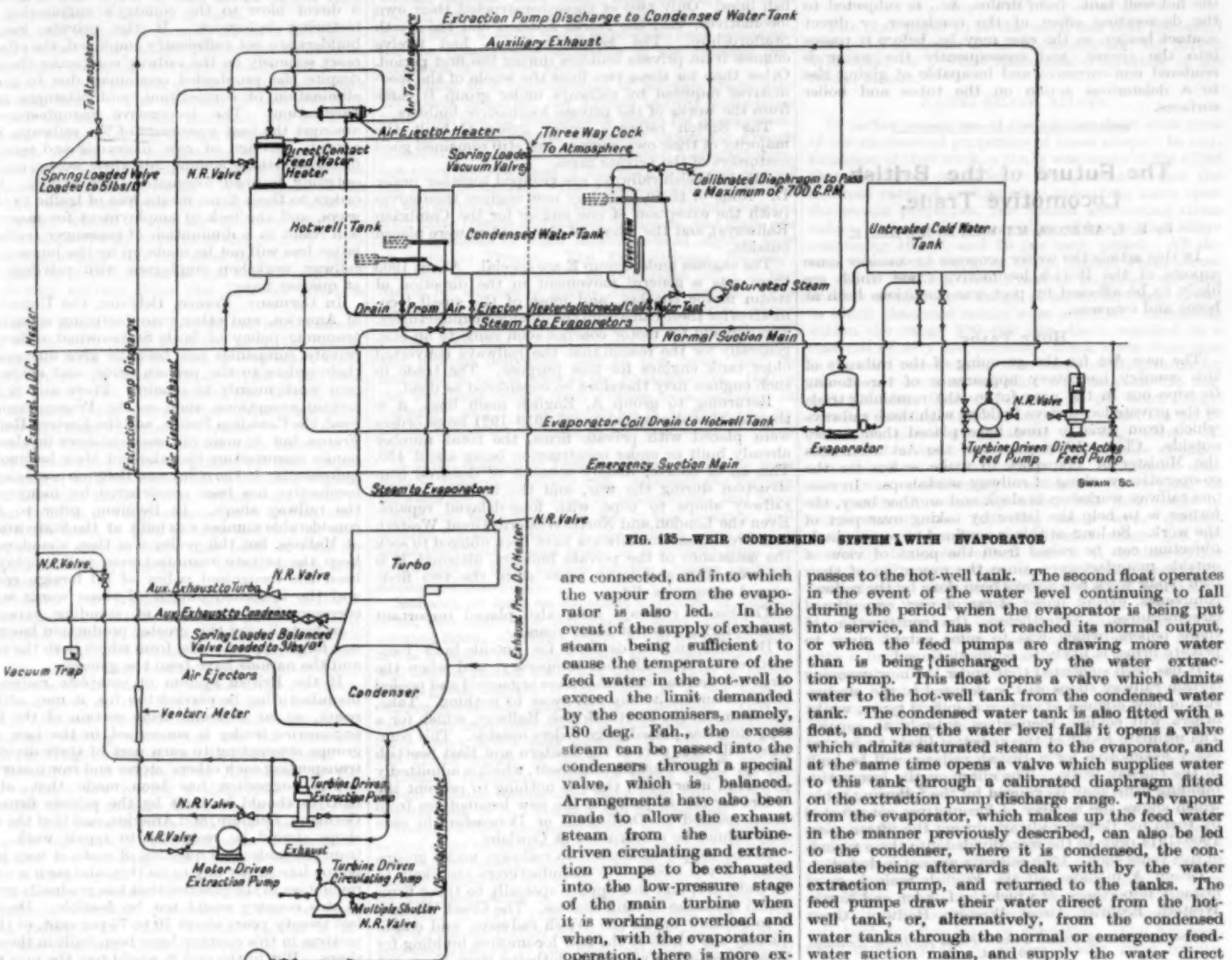


FIG. 135—WEIR CONDENSING SYSTEM WITH EVAPORATOR

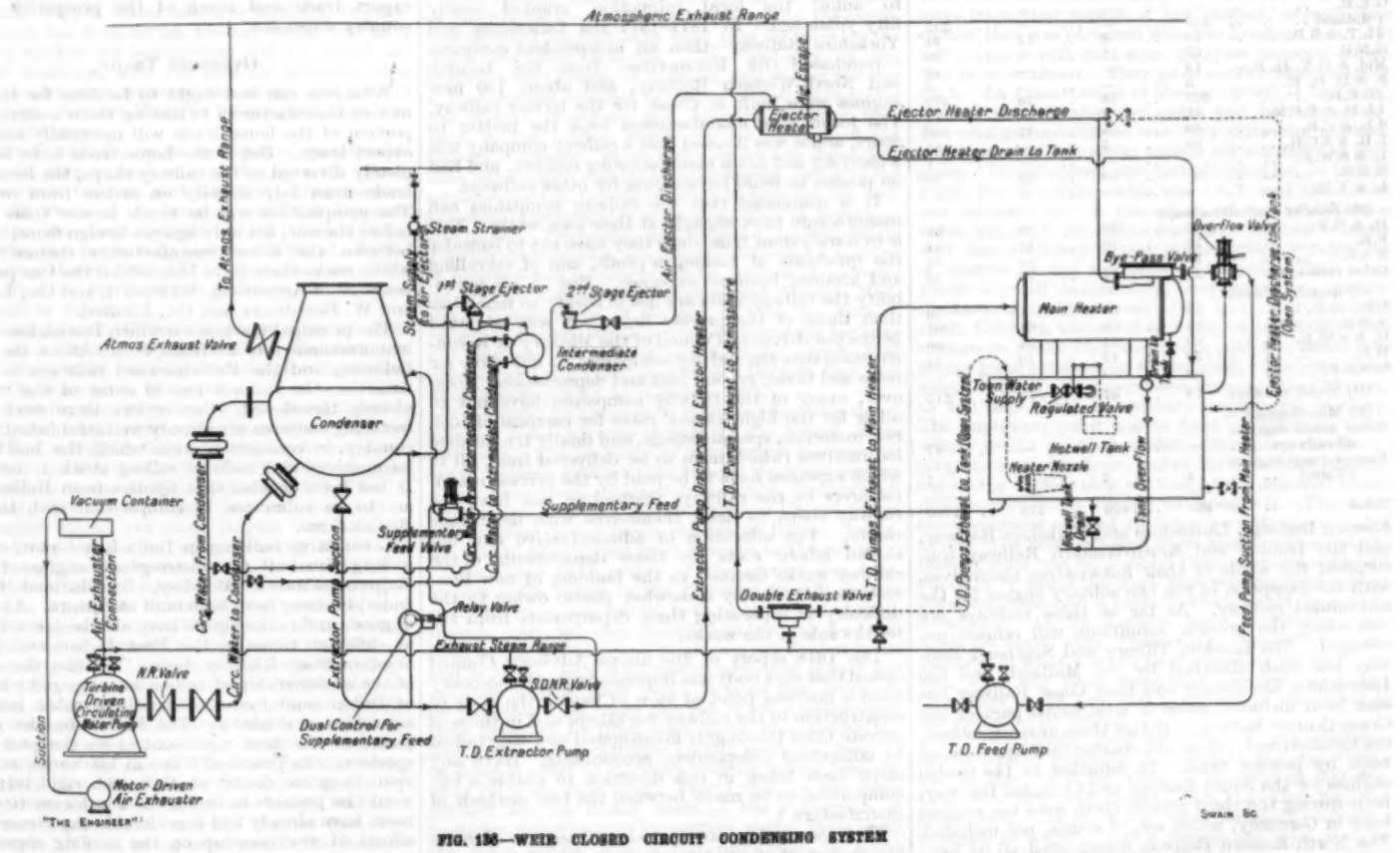


FIG. 136—WEIR CLOSED CIRCUIT CONDENSING SYSTEM

Condensing plants arranged in accordance with this scheme form a complete condensing, make-up and feed heating system, and offer the important advantage that from the time the feed water leaves

the condenser until it reaches the boilers it is contained in a closed circuit, with the result that the water has no opportunity of absorbing air, whilst at the same time the whole of the feed water from the hot-well tank, from drains, &c., is subjected to the de-aerating effect of the condenser or direct contact heater, as the case may be, before it passes into the circuit, and consequently the water is rendered non-corrosive and incapable of giving rise to a deleterious action on the tubes and boiler surfaces.

The Future of the British Locomotive Trade.

By E. L. AHRONS, M.I. Mech. E., M.I. Loco. E.

IN this article the writer proposes to consider some aspects of the British locomotive trade which are likely to be affected by post-war conditions both at home and overseas.

HOME TRADE.

The new Act for the grouping of the railways of this country has every appearance of threatening to wipe out in the near future the remaining trade of the private locomotive builders with those railways which from time to time have placed their orders outside. Clause 12 of part 2 of the Act authorises the Minister of Transport to make orders for the co-operative working of railway workshops. In case one railway workshop is slack and another busy, the former is to help the latter by taking over part of the work. So long as this is confined to repairs little objection can be raised from the point of view of outside manufacturers, since the execution of their own repair work has always been done by the railway companies, except under stress of very exceptional circumstances. Nevertheless, the construction of spare boilers, which was to some extent given to private firms, is likely to be discontinued.

It has been suggested that under the new grouping certain railway shops will be devoted to the production of new engines of certain standard types, whilst others will confine themselves entirely to repairs. The ultimate result of this policy is likely to be that every locomotive for a British railway will be built in the railway works. The effect on the locomotive building firms may be gauged by the following table, which shows the number of locomotives constructed by them for British railways during the fifteen years 1900–1914 prior to the war, divided into three periods of five years each. Irish railways are not included.

Locomotives Built by British Private Firms for Home Railways, 1900–1914.

	1900–4.	1905–9.	1910–4.	Total.
(A) English main lines—				
L. & N.W.R.	—	—	—	—
G.W.R.	—	—	—	—
G.E.R.	—	—	—	—
Midland	232	—	—	232
L.T. & S.R.	24	8	12	44
G.N.R.	37	1	—	38
Mid. & G.N. Jt. R.	12	—	—	12
S. & D. Jt. R.	5	—	—	5
G.C.R.	227	76	70	373
L.D. & E.C.R.	11	3	—	14
S.E. & C.R.	80	—	12	92
L.B. & S.C.R.	60	5	—	65
L. & S.W.R.	1	—	—	1
N.E.R.	—	50	20	70
L. & Y.R.	—	—	—	—
(B) Smaller English railways—				
H. & B.R.	32	35	30	97
F.R.	16	16	12	44
N.S.R.	12	—	—	12
Other railways	28	17	10	55
(C) Scotch railways—				
C.R.	50	—	—	50
N.B.R.	40	68	94	202
G. & S.W.R.	30	12	38	80
H.R.	20	15	10	45
G.N.S.R.	—	—	—	—
(D) Welsh railways	78	67	70	215
(E) Miscellaneous—				
Motor coach engines, all railways	—	47	—	47
Narrow-gauge engines (Wales)	4	3	—	7
Total	999	423	378	1800

Eastern Railway, Lancashire and Yorkshire Railway, and the London and South-Western Railway constructed the whole of their locomotives themselves, with the exception of the one solitary engine for the last-named railway. As far as these railways are concerned, the pre-war conditions will remain unchanged. The London, Tilbury and Southend Railway has been absorbed by the Midland, and the Lancashire, Derbyshire and East Coast Railway has also been included, since it now forms part of the Great Central Railway. Before these amalgamations, the locomotives for these two smaller railways were all built by private firms. In addition to the twelve engines for the South-Eastern and Chatham Railway, built during the third period, there were ten engines built in Germany, which are, of course, not included. The North-Eastern Railway constructed all its locomotives at its own works from 1885 to 1908, but in the latter year was compelled to seek the assistance of the private builders. With this exception, group A as a whole shows a very great reduction in the number of outside-built engines between the first and last periods.

Under B are grouped together all the smaller English lines. Only two of these constructed their own locomotives, viz., the North London and the North Staffordshire. The latter, however, had twelve engines from private builders during the first period. Other than for these two lines the whole of the locomotives required by railways under group B came from the works of the private locomotive builders.

The Scotch railways under group C built the majority of their own engines, but still remained good customers of the private firms.

All the Welsh railways are grouped together under D. None of them built any new engines themselves (with the exception of one engine for the Cambrian Railways), and the whole of their orders were placed outside.

The engines under group E are special. About 1905 there was a general movement in the direction of steam motor coaches, and most of the small locomotives for these came from the outside manufacturers. The demand for motor coaches soon came to an end, generally for the reason that the railways converted older tank engines for this purpose. The trade in such engines may therefore be considered as dead.

Returning to group A, English main lines, it is the case that during the years 1919–1921 large orders were placed with private firms, the total number already built or under construction being about 450. This is, of course, mainly a result of deferred construction during the war, and the inability of the railway shops to cope with long-delayed repairs. Even the London and North-Western, Great Western and Great Eastern railways have been obliged to seek the assistance of the private builders, although it is between fifty and sixty years since the two first-named companies did so.

The Scotch railways have also placed important orders during the last three years.

But this sudden demand for outside-built locomotives is, after all, but temporary, and when the large new railway combines have organised and pooled their resources, it may fall away to nothing. Take, for example, the North British Railway, which for a long time has placed large orders outside. This company will form part of the Eastern and East Scottish Group. Unless Scottish sentiment, which is admittedly powerful, intervenes, there is nothing to prevent the orders for the majority of the new locomotives from being handed to Darlington or Doncaster, in case they cannot be constructed at Cowlairs.

In the supply of engines to railways under groups B and D the locomotive manufacturers are likely to be badly hit, and this applies specially to those firms which specialise in tank engines. The Great Western is to swallow up all the Welsh railways, and consequently the whole of the new locomotive building for these lines, all of which has hitherto been given out to private firms, will henceforth probably be concentrated at Swindon.

The practical effect of these changes will be to annul the legal injunction granted nearly fifty years ago. In 1871–1874 the Lancashire and Yorkshire Railway—then an independent company—purchased its locomotives from the London and North-Western Railway, and about 100 new engines were built at Crewe for the former railway. The locomotive manufacturers took the matter to court, and it was decided that a railway company was a carrying and not a manufacturing concern, and had no powers to build locomotives for other railways.

It is contended that the railway companies can manufacture more cheaply at their own works. This is to some extent true, since they have not to consider the questions of making a profit, and of travelling and kindred business expenses. But in all probability the railway costs are not in reality so much less than those of the private firms. It was admitted before the Advisory Council of the Ministry of Reconstruction that the railway companies do not allow for rates and taxes, ground rent and depreciation. Moreover, many of the railway companies have not to allow for the high traders' rates for carriage of fuel, raw materials, special fittings, and finally the finished locomotives (which have to be delivered free), all of which expenses have to be paid by the private manufacturers to the railways themselves, nor have the railway shops to debit themselves with demurrage claims. The allocation of administrative and unskilled labour costs for those departments of the railway works devoted to the building of new locomotives is probably somewhat elastic owing to the difficulty of separating these departments from the repairs side of the works.

The 1918 report of the above Advisory Council stated that that body was impressed with the necessity from a business point of view of having the costs of construction in the railway workshops and in those of private firms thoroughly investigated and ascertained by competent independent accountants. Have any steps been taken in this direction to enable a fair comparison to be made between the two methods of manufacture?

There is another cause which will tend to decrease the output of steam locomotives in the future, viz., the electrification of railways in certain districts, more especially in thickly populated suburban areas. It is noteworthy that, except on the Great Northern Railway, very few tank engines for local passenger traffic have been built for home railways during the last twelve years.

In many respects the new Railway Bill is therefore a direct blow to the country's engineering manufacturing industries. If the private locomotive builders are not sufficiently employed, the effects will react seriously on the railway companies themselves, despite the prophesied economies due to grouping, elimination of competition, and attempts at standardisation. The locomotive manufacturers are amongst the best customers of the railways, both as regards carriage of raw materials and semi-manufactured articles coming into their works, and of the outgoing finished locomotives for export. Loss of orders to these firms means loss of traffic to the railways, and the lack of employment for many hands will result in a diminution of passenger traffic. The latter loss will not be made up by the journeys of the railway workshop employees with privilege tickets at quarter fares.

In Germany, France, Belgium, the United States of America, and other manufacturing countries, the economic policy of both State-owned railways and private companies has been to give out nearly all their orders to the private firms, and confine their own work mainly to repairs. There are, it is true, certain exceptions, such as the Pennsylvania Railroad, the Canadian Pacific, and the Eastern Railway of France, but in none of these instances do these companies manufacture the whole of their locomotive requirements. In Germany and Belgium not a single new locomotive has been constructed for many years in the railway shops. In Belgium, prior to 1870, a considerable number was built at the State workshops at Malines, but this policy was then abandoned. To keep the private manufacturers well employed has been the recognised policy of all foreign countries, and the increased output of these works with the corresponding spreading of standing expenses or "on-costs" over this greater production has resulted in a larger export trade, from which both the railways and the nations have been the gainers.

If the British system of complete railway shop manufacturing be carried too far, it may ultimately result, so far as traffic from certain of the finished engineering trades is concerned, in the new railway groups attempting to earn part of their dividend by transporting each others' stores and raw materials.

The suggestion has been made that all locomotives should be built by the private firms, as in Germany, Belgium, and America, and that the railway shops should be restricted to repair work. Apart from the undecided question of costs, it may possibly be too late in the day to do this, and such a complete revolution in the practice that has gradually grown up in this country would not be feasible. During the last twenty years about 70 to 75 per cent. of the locomotives in this country have been built in the railway shops. But in the end it would pay the new railway groups if they reserved at least a considerable percentage of their locomotive requirements for construction by the private firms, on which, after all, the export trade and much of the prosperity of the country depends.

OVERSEAS TRADE.

Whatever can and ought to be done for the locomotive manufacturers in leaving them a certain proportion of the home trade will materially assist the export trade. But if the home trade is to be completely diverted to the railway shops, the locomotive trade must rely entirely on orders from overseas. The competition will be much keener than it was before the war, not only against foreign firms, but also between the home manufacturers themselves, to whose ranks there have been added the two powerful concerns of Armstrong, Whitworth and Co., Limited, and W. Beardmore and Co., Limited.

The principal markets on which British locomotive manufacturers rely are India, South Africa, the Crown Colonies, and the British-owned railways in South America. In India a loss of some of the trade is already threatened. One or two large steel manufacturing concerns are already well established in that country, in connection with which the building of locomotives and railway rolling stock is intended. It has been decided that tenders from Indian firms are to be submitted in competition with those of British firms.

Locomotive building in India is not new, and for a long time all the metre-gauge engines for the Rajputana-Malwa (Bombay, Baroda and Central India) Railway have been built at Ajmere. A number of goods and tank engines have also been constructed at different times in the East Indian and North-Western State Railway shops. Whether the quality of the workmanship of Indian as compared with that of British-built locomotives will be taken into consideration is doubtful. The British builder is subjected to the most rigid control on the part of inspectors, who practically live in his works, and it is open to grave doubt whether such rigid inspection would be possible in India. Indian locomotive engineers have already had considerable experience of the effects of workmanship on the hauling capacity of their engines. Some years ago tests were made on the East Indian Railway of the drawbar pulls of British and German-built 0–6–0 goods engines of the same (British) design, when it was found that the drawbar

horse-power of the British-built engine was 82 per cent. of the indicated horse-power, whilst the German engine showed 75 to 72 per cent. only.* The German engines were also found to cost about 50 per cent. more in repairs and renewals of parts.

Nevertheless, in spite of considerations of workmanship, the present policy of the Indian Government in fostering home industries will undoubtedly lead to the withdrawal of some portion of the locomotive orders from British firms. The question of cost will bulk largely and the native Indian mechanic will work for much lower wages than his British *confrère*.

In South Africa the competition is that of the American firms, and will mainly depend upon prices and, above all, quick deliveries. With regard to the latter, the American firms are frequently able to obtain orders which, if quicker delivery could be assured, would be likely to come to this country. But the American engine does not seem to give the same good results in South Africa as the British engine, if the following extract from the *Pretoria News* is correct :—

"We have heard a good deal of the huge railway engines which were being built for us in the States. These engines have been at work a very short spell, and forty are in the repair shops. With a full load they take twenty-two hours where the British take fifteen, and their boiler stays have collapsed, entailing long delay and huge expense for repairs."

The Crown Colonies and Protectorate railways in Asia and Africa have hitherto placed all their orders in this country, with the exception of fourteen engines for the Federated Malay States, which were given to American builders in 1919, on account of the inability of the British firms to give prompt delivery at that time. Twenty engines were also built in 1919 for the Nigerian Railway, ten in the United States and ten in Canada.

Locomotives for Australia and New Zealand, countries which at one time were very good customers of the British builders, are now mostly made in their own works. A welcome return of New Zealand business to this country has recently occurred after many years' absence in the shape of a good order for forty-five engines given to the North British Locomotive Company, Limited. At one time the tendency of the New Zealand railway authorities was to order in America such engines as could not be built at home.

The British-owned railways in Argentina at the time of writing are having a difference with the Government of that country, since the latter has suspended the increases in rates and fares necessary to make up for the greatly increased costs of operation. Negotiations are pending, but until a satisfactory outcome is assured, the prospect of future orders for rolling stock, &c., is lessened. In other South American countries, with the exception of two or there Brazilian railways in which British capital is interested, the American firms seem for the present to be in the ascendant, though this situation has resulted at the expense of German rather than of British firms.

What the future will bring forth in Egypt is at present problematical, and it is useless to discuss what may happen under the new National Government which has been set up, beyond saying that as in the past tenders for locomotives will be asked for from all countries, with the possible difference that if British control is removed the cheap and inferior article is much more likely to be accepted than was formerly the case.

The trade with Japan, at one time of considerable magnitude, may be said to have disappeared. From 1905 onwards German and American firms secured nearly the whole of the business until the Japanese workshops, including a private firm of builders, found themselves in a position to meet the demand. In the year ending March, 1915, 132 new engines were added to the stock of the Japanese railways, all of which were built in Japan.

The situation in China was dealt with at some length in a leading article in THE ENGINEER of August 20th, 1920, and in the issue for September 23rd, 1921, were given the results of open tenders for locomotives for the Chinese railways. Recapitulating these figures which were taken from the *Hongkong Daily Press*, a Belgian firm tendered the lowest price, equivalent to £9150 each for thirty 2–6–2 engines, for which the lowest British tender was £13,675 c.i.f. Liverpool. For six additional engines, described as of "English type," the same Belgian firm also put in the lowest tender of approximately £9675 per engine, as against the lowest British tender of £11,000. The highest British tender for these was £17,280.

But the Americans have already gained a very strong footing in China, and it will take all the energy and resources of British builders to hold their own. At a meeting of the Institution of Locomotive Engineers in 1920, one of the speakers, a British engineer from the Pekin-Mukden Railway, stated that for some years the Pekin-Mukden and other Chinese railways had not purchased any British locomotives partly owing to the war and the cost, but also owing to the fact that the Chinese themselves prefer the American engines, as many of the details had been found more convenient, and the engines had done better work. It is to be regretted that in this instance the American engines, which carried a pressure 20 lb. or 30 lb. per square inch in excess of that of the British engines, were, compared with the oldest type of the latter, constructed when the railway was first opened. Both engines were of the outside-cylinder 2–6–0 type with 4ft. 6in. wheels. The British engines were fitted with ordinary D slide valves, whereas the American engines had balanced slide valves, a detail which appears to have accounted for the considerable difference in the running performance of the two types.

Turning to a consideration of possible trade with European countries, the French railway authorities have been placing considerable orders for locomotives. During the war several important orders for French locomotives were executed by British manufacturers, but since the war most of the work given out abroad has gone to America. The American firms are willing to, and actually do, construct engines to French designs, with plate frames and copper fire-boxes, and there are large numbers of such American-built engines now at work in France. The Paris-Orleans Railway, however, recently placed an important order in the States for engines of purely American design. It is regrettable that constant strikes and general labour unrest in this country have so greatly handicapped British firms that the latter could not promise definite and prompt deliveries, and to this cause may be ascribed the loss of some of the French orders. Before the war large orders from France were executed in Germany, and it now appears as if America had replaced the latter country, to the detriment of Great Britain.

A small number of French engines have also been built in Belgium since the war. Although the Belgian railways are badly in need of locomotives, and have placed one large order for 200 in this country, and another for 150 in America, the Belgian firms are not neglecting their foreign trade, as is evident from the particulars of their tenders for the Chinese railways mentioned previously.

Holland, so long an excellent customer of British firms, has since the Armistice placed orders with German firms. Of these, thirty 4–6–0 express engines are of a design previously made and constructed by a well-known British firm, but another type of heavy 2–8–0 goods engines is the result of a few similar engines previously obtained from Germany. One or two orders have been placed in this country, including some heavy 4–6–4 tank engines (3ft. 6in. gauge) for the Dutch colony of Java. The latter is an encouraging symptom, since for many years all the Dutch colonial locomotives have been built either at Amsterdam, or in Germany and Switzerland.

Italy, though becoming more and more self-contained in its locomotive production, formerly obtained most of its foreign-built engines from Germany, but shortly before the end of the war placed a huge order for 400 locomotives in America, most of which were delivered in 1918–1920. These engines are of the 2–8–0 type of Italian design in their main features, and weigh empty 57 tons each, with tenders weighing 21.7 tons. The price of these engines was (1917) 650 dols. per British ton (1016 kilos.) at the works, plus cost of freight and transport.

The Spanish market has not for many years been of much assistance to British builders, with the exception of a few engines built from time to time for the Great Southern Railway. The majority of the engines were German or Alsatian, and during the war a considerable number of heavy 4–8–0 engines for the Madrid, Zaragoza and Alicante Railway were built in the United States to the designs of the railway company. Spain will now be less dependent than before upon outside manufauturers, owing to the establishment of two large new concerns for the construction of locomotives and rolling stock at Barcelona and Bilbao. The former establishment, La Maquinista Terrestre y Maritima, has already delivered a number of heavy 4–8–0 passenger tender engines of an order for fifty for the Madrid, Zaragoza and Alicante Railway. Nevertheless, at the end of 1920 the Spanish railways obtained tenders from all countries for over 100 engines, the lowest prices being about 3485 pesetas per British ton, quoted by a German firm, and 3220 pesetas per ton by a Belgian firm.

A German firm has recently delivered five large three-cylinder 4–6–0 express engines to the Danish State Railways. The majority of the Danish locomotives are of German construction, though there are engines which have been obtained from Italy, Switzerland, Sweden and Belgium, and in 1920 the United States built sixteen 2–6–0 goods engines of Danish design, the first to be exported from America to Denmark.

The above brief review of the present-day locomotive trade points in the direction of still greater competition in the future, both at home and abroad, though, provided that British builders can be freed from labour troubles, and be given a fair field at home and in India, there is no reason why they should not continue to hold their own. It must not, however, be forgotten that there are two more mouths—and large ones—to be filled than there were before the war, and a correspondingly greater trade will have to be done in order to fill them without taking business away from the older firms. Seeing that the new competitors are the direct result of the conversion of munition factories into locomotive works, there is all the more reason why a fair proportion of home railway orders should be allotted to the private firms to enable them to keep the increased establishments employed, and this would certainly be in the national interest.

* These figures are those published in *Eastern Engineering*.

Institute of Metals.

No. IV.*

THE next paper to be discussed was that presented jointly by Professor F. C. Thompson and Mr. Edwin Whitehead on "Some Mechanical Properties of the Nickel Silvers."

Nickel-Silver Alloys.

In earlier papers one of the authors dealt with some of the mechanical properties of these alloys. In continuation of that work, a study was made of the effect that annealing at different temperatures, and the different rates of cooling after annealing, have upon the tensile properties, the Arnold alternating stress values, and the Erichsen values of hard-rolled alloys containing 10, 15, and 20 per cent. nickel. All the tests showed the influence of the change which occurs at about 300 deg. Cent., and in addition, revealed another temperature range at about 550 deg. Cent., in which abnormal results were obtained. Annealing within the range 300–400 deg. Cent. resulted in a material of very low ductility, much lower than that in the hard-rolled state. The best annealing range for the 10 per cent. nickel alloy was between 725 deg. and 825 deg. Cent.; for the 15 per cent. nickel between 700 deg. and 800 deg. Cent.; and for the 20 per cent. nickel alloy, about 800 deg. Cent. As the nickel content was raised the tensile strength was raised somewhat, while the maximum ductility was considerably reduced. As typical of the results of annealing within the best range of temperatures, the following tests were quoted. Quenching from the annealing furnace has no markedly beneficial effect, but if it is desired for economical reasons then the quenching should be done at once, without allowing the metal to cool, or erratic and brittle material may result. So far as the Brinell hardness is concerned, almost the whole of the softening takes place in the first two hours, with a further slight fall as the time of annealing is increased. The greatest ductility, and also the highest Erichsen values are obtained after a duration of annealing of 1½ hours, for the small samples used. There is little to choose between annealing the alloy for a short time at a high temperature and for a longer time at a low temperature. The ratio between the maximum stress and the Brinell hardness number is only about half for the hard-rolled material that it is for the soft annealed. One of the most remarkable features of the results obtained is the high temperature to which the alloys can be heated without deterioration, especially when the sample is protected from oxidation. The furnace gases play a very important part in the production of "burnt" material; this incidentally is a point in favour of the salt bath for this type of annealing. The Erichsen tests, especially, all show remarkably good results, even after annealing at as high a temperature as 850 deg. Cent.

Mr. F. S. J. Pile expressed regret that the authors had, from the commercial point of view, missed the most important aspect of the subject, namely, the surface that was obtained with the Erichsen test. He had brought with him some samples of metal which had been returned. They gave an Erichsen value of 13.1. An examination of the rim where it had been worked showed why the metal had been returned. The orange-peel surface was very distinctly marked, and the metal was quite useless for commercial purposes. He exhibited two further samples, in one of which the Erichsen value was 11.7, and the metal was satisfactory; in the other, where the Erichsen value was 11.5, the metal was bad. He had brought with him a variety of test pieces, which it might be of interest to the members to inspect. They were practically all satisfactory, and gave, on various thicknesses ranging from .047 and .042 down to .014, Erichsen values of from 10.95 to 12.55. The surface in every case was good, and the metal was giving great satisfaction to the users. The specimens were annealed at temperatures varying from 700 deg. to 750 deg. Cent. in ordinary commercial working. The important point was to have an Erichsen value which would produce metal sufficiently ductile to give the necessary draw, and at the same time possessing such a surface that the cost of the material would not be doubled by having to burnish it. The same considerations applied to brass as well as to nickel silver. The great demand upon manufacturers at the present time was for a metal that possessed sufficient ductility to stand the work that was required and at the same time had a surface which could be readily burnished. If the authors were continuing their work, he hoped they would apply themselves to the question of what was the best annealing temperature, and, what was more important, perhaps, to a consideration of the previous treatment of the metal in the course of its rolling.

Dr. D. Hanson drew attention to the existence of the critical points in the alloy at 300 deg. Cent., and at about 570 deg. Cent. The point at 300 deg. Cent. was very well marked, but the other was less prominent, though there was certainly sufficient evidence to suggest that a change did take place in some of the samples at about that temperature. Such a change, it appeared to him, ought to be related in some manner to the constitution of the alloys. So

* No. III. appeared March 24th.

far as was known, copper and nickel formed a simple series of solid solutions, and there was no change that was at present known that would explain the results of those mechanical tests. It was true that nickel possessed a low-temperature critical point, but there was not, at present, any evidence to suggest that that particular critical point could be connected with those anomalies. It seemed to him that before any finality could be arrived at as to the mechanical properties of cupro-nickel those anomalies must be investigated and explained.

Mr. W. B. Clarke said the work which had been done was of great interest to all those connected with the manufacturing side of the industry. It raised the whole question of annealing practice in general, and also the question of annealing the particular alloys to which reference was made. With regard to the results from the surface point of view that had been put forward by Mr. Pile, he desired to say that, from a vast amount of experience in annealing all kinds of non-ferrous metals, more particularly in the form of wires and sheets, he thought the non-ferrous metal industry would save thousands of pounds a year if it would only adopt the up-to-date common-sense method of bright annealing all products. During the last twelve months, he had had some experience with a large number of very thin metal stampings and spinnings, and some that had been received from the manufacturers were, he would not say a disgrace to them, but still they should never have been turned out of any manufacturer's shop. The amount of pickling and polishing required to clean them accounted for at least 10 per cent. or 15 per cent. of the amount of metal used. With regard to annealing in a muffle furnace, if the furnace was of the open type, either gas or coke-fired, where sulphur fumes were liable to be present, it would be found that a very great amount of scaling was obtained. If a closed muffle furnace was used, very great pains indeed had to be taken, especially with the nickel alloys and nickel-copper alloys, to see that there were no cracks. It would be found that the average muffle furnace cracked after two or three weeks' use, and, unless it was flooded out with clay to fill up the cracks, some remarkable results were obtained. With regard to blacklead and clay crucibles, and the results obtained therefrom, the percentage of carbon was rather high, and was a cause of trouble, although, reckoned in percentages .1 or .2, it was not a large amount. The remedy he had adopted to reduce the carbon content was to paint the inside of the blacklead crucible with one or two coats of fire-clay, such as Osmos clay, and to dry it well on. On the subject of annealing, he would like to know if the time given in the paper was the time the metal was subjected to the maximum temperature or the time it was in the furnace and being heated up. The rapidity with which the desired temperature was reached was an important point.

Mr. Edwin Whitehead, in reply, said the principal point which the authors had desired to demonstrate was the effect of the annealing upon the mechanical properties of the material. The effect that annealing had upon the surface of the metal, judged by the Erichsen test, had been a secondary consideration, but the authors would in future pay attention to that question and make it of primary importance. Mr. Barclay had suggested that the annealing temperature of 800 deg. Cent. was too high. From the results obtained, the greatest ductility seemed to have occurred at about that temperature in all the alloys used. The critical points round 300 deg. and 570 deg. Cent. were quite well marked, but Dr. Hanson seemed rather to doubt the accuracy of the 570 deg. point. In all the work done by the authors, the 570 deg. point was very outstanding. With regard to the effect of impurities upon the changes, the alloys with which the authors had been dealing were essentially commercial alloys, and, being such, they had a purity which corresponded to the purity of the ordinary everyday alloy. He hardly thought the 570 deg. point could be due to impurities, because the magnitude of the change was so very great. Even if it were due to the impurities, considering that they were commercial alloys with which the authors were dealing, it must be taken more or less for granted that they existed in commercial alloys which were used in everyday work. The muffle used was of the ordinary open type, and in the majority of cases at 500 deg. Cent. and upwards the metals were protected by plaster of Paris packing. The time of annealing stated was that for which the specimen was actually in the furnace.

A paper entitled "A Further Study of the Alloys of Aluminium and Zinc," by Dr. D. Hanson and Miss Marie L. V. Gayler was then presented by the last named.

Alloys of Aluminium and Zinc.

The work described in this paper was undertaken with a view to investigating further the constitution of the phase known as delta in the diagram of Rosenhain and Archbutt. In some preliminary experiments, alloys containing 70, 60, and 50 per cent. of zinc, when slowly cooled to 284 deg. Cent., after prolonged annealing at 420 deg. Cent., and quenched, were found to be duplex in structure. The inconsistencies between these micro-structures and those suggested by the existing diagrams led to a re-determination of the solidus from 81 per cent. zinc to 20 per cent. zinc. The results obtained differed appreciably from those of previous workers; the line representing the peritectic reaction was found to extend up to a composition of 70 per cent. zinc as against 40 per cent. zinc in previous diagrams. Microscopic examination of the alloys, following special heat treatment, disproved the existence of the compound Al_2Zn_3, and showed that the nature of the change in the alloys at the temperature of the horizontal line at 256 deg. Cent. in Rosenhain and Archbutt's diagram was identical with an ordinary eutectoid transformation, the decomposition of the beta phase leading to the "pearlitic" structure commonly found in the alloys. Further work on alloys at temperatures below 256 deg. Cent. showed that the solubility of the alpha constituent in the gamma constituent decreased with the temperature. Alloys containing the beta constituent were found to possess the property of age-hardening spontaneously at room temperature after being quenched from above 256 deg. Cent., while those containing the gamma constituent showed the property, but in a much less marked degree.

Dr. W. Rosenhain said that he desired to say what the authors had refrained from saying too emphatically, namely, that the paper constituted a correction of, and was certainly an improvement upon, the diagram of the aluminium zinc system which Mr. Archbutt and himself produced some years ago. The reason why a diagram produced at the present time should be more correct that one which was produced ten years ago was quite obvious, namely, the advancement in the methods of studying alloys and obtaining equilibria. What Mr. Archbutt and himself regarded as a very slow rate of cooling would be regarded by the present authors as altogether inordinately fast. They dealt in days and weeks where Mr. Archbutt and himself had dealt in minutes and hours. That had been rendered possible mainly because of the development of improved thermostat apparatus. The paper was interesting because of the light it threw upon the nature of the transformations which led to hardening and tempering. In connection with the alloys of aluminium which contained small quantities of magnesium and duralumin, the alloy Y and others, the conclusion had been reached that a hardening process occurred which was in every way directly analogous to certain phases of the hardening process which occurred in carbon steels, particularly alloy steels.

Professor Thomas Turner welcomed the new diagram as giving a very much more complete and rational explanation of this series of alloys than had been possible from deductions drawn from earlier work. He suggested that the influence of surface tension should be investigated. He felt that very substantial progress was being made in the study of the alloys referred to in the paper at the National Physical Laboratory at the present time. The country and the industry was indebted to those engaged in the investigations.

The presentation of a note on "The Assay of Gold Bullion," by Mr. Arthur Westwood," concluded the programme of the meeting.

Assay of Gold Bullion.

Mr. Westwood, in his paper, suggested a new method of assay of gold bullion. The method universally adopted at the present time of assay by cupellation, inquartation, and subsequent parting, is of very ancient origin. In this latest method the assay sample is not cupelled, but is melted and balled up under steam or an inert gas. For the usual inquartation, copper is recommended in place of silver.

Professor T. Turner said that the old method of cupellation in the assay of gold bullion was so ancient that one was surprised to find that another simple method could be introduced and applied. The new process had been in use in the Assay Office at Birmingham for nearly three years, during which time something like 300 assays had been made daily. The results had been very carefully checked against the older process. The new method possessed certain advantages, including the fact that it was possible to determine approximately the proportion of zinc that was present because it was volatilised. Further, there was no interference by the presence of certain other metals, such as aluminium, and the amount of iron could be determined. The iron could be separated and a surcharge was not obtained. In the ordinary method of assaying there was always a small proportion of silver as a surcharge. The great point of the new process was that copper was used instead of silver, and for some alloys, particularly the 9-carat and 12-carat gold, the low-carat qualities, that method possessed advantages. For the high carat gold the older method was still generally used.

Worm Reduction and Change-speed Gearing.

Our attention has recently been drawn to what is claimed to be an entirely new form of speed reducing and changing gearing. This system is the invention of Major E. C. Hatcher, and is being developed by the "H.R." Reduction Gear Syndicate, of 168, Regent-street, London, W. The novelty of the invention consists of the entire absence of the usual spur wheels and the use instead of worms and worm wheels. At first sight the idea seems so simple and obvious that one may be pardoned for suspecting its originality. Nevertheless, we have to record that we have failed in a search to discover an anticipation of the idea, while greatly more convincing of its novelty is the fact that the inventor has been granted patent rights for the application of the principle by Great Britain, the United States, Spain, France, Germany, Belgium, Italy, and Switzerland. The system has many applications, although few of them have as yet been put into actual service. It can be used, it is claimed, as an alternative to ordinary spur reduction gearing wherever the latter is applied, even for the main turbine drive in steamships. As for its advantages, we need here only say that they are stated to be numerous, leaving consideration of the more important until we have described the general principle of the system and one or two particular applications.

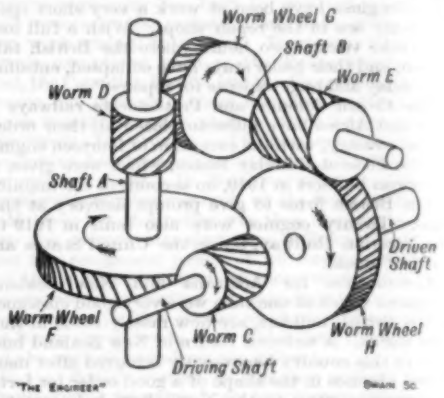


FIG. 1—DIAGRAM OF "H.R." WORM REDUCTION GEAR

A diagram illustrating the construction and action of the new gearing is given in Fig. 1. The driving and the driven shafts are coaxial. At right angles to them and to each other are two shafts A B. Driving connection is established by the three worms C D E and the three worm wheels F G H, the first worm being on the driving shaft and the last worm wheel on the driven shaft.

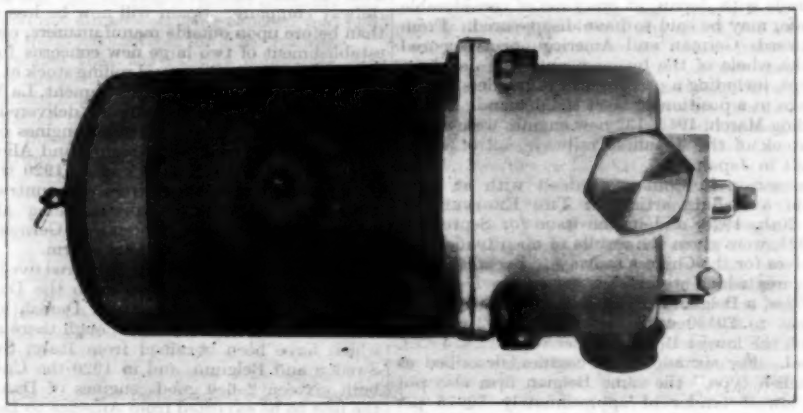


FIG. 2—APPLICATION OF "H.R." REDUCTION GEAR TO MOTOR CAR STARTING AND LIGHTING SET

As an example of the application of the drive we may take a motor car starting and lighting set, a sample of which has been submitted for our inspection. In this case the driving shaft, Fig. 1, is directly connected to a small motor generator. The worm C is not fixed to the driving shaft, but slides on a key thereon, its movement being limited to a range of about $\frac{1}{16}$in. by a collar on the driving shaft on the side of the worm C remote from the driven shaft. On the face of the worm C nearest the driven shaft dog clutch teeth are formed. Similar co-acting teeth are provided on the adjacent end of the driven shaft, which for this purpose is enlarged and bored out to accommodate loosely the end of the driving shaft. To start the car energy is supplied to the motor generator, the power being transmitted through the gearing at a slow speed to the driven shaft and thence to the engine. While the motor is thus driving the engine the thrust on the worm C is such as to move and hold the worm against the collar on

the driving shaft. When, however, the engine picks up its speed the worm wheel F tends to over-run the worm C, the direction of the thrust on the latter is reversed, and it slides forward on its key until the clutch teeth come into engagement. The motor generator thus becomes directly coupled to the engine, and instead of driving it is driven by it. It therefore changes its function to that of a generator and charges the lighting batteries. In order that this arrangement may be made effective it is necessary to mount the shafts A B and their worms and wheels in a frame that is free to rotate in one direction inside the casing enclosing the whole gear and prevented from rotating in the opposite direction. To this end, when the motor is driving the engine, the frame is prevented from turning in the direction opposite to that in which the motor armature rotates by means of six friction balls lying against cam faces inside the casing and nipping against a plain cylindrical surface on the frame. When the engine is driving the generator directly, the balls moving on the cam faces release their grip on the frame and allow it and the shafts A B, &c., to rotate at the same speed and in the same direction as the coupled driving and driven shafts. It is to be added that the cam faces are formed on the inner circumference of a ring held within the casing by two spring plungers. Should the engine back fire during the starting period the plungers allow the ring to slip and thus damage to the ring, balls or frame is avoided. It may also be noted that an additional shaft connected through worm gearing to the driven shaft is provided. This shaft is intended for driving the magneto or speedometer. Fig. 2 shows the complete gear system with its aluminium casing bolted to the body of the motor generator, while Fig. 3 illustrates the general arrangement of the gearing portion.

The application of the system to motor car lighting and starting as described above represents the original object for which the gearing was invented. It was, however, soon appreciated that the field for its employment could be greatly extended, particularly if it could be made to serve as a speed changing as well as a speed reducing gear. Developed in this form it is now being made for the operation of chain-grate stokers and is shortly to be produced as a four-speed and reverse gear for motor cars. In addition attention is at present being paid to its application to cranes and winches, motor cycles, machine tools, and bascule bridges.

The general arrangement of a four-speed reduction gearing of Major Hatcher's design as applied to a Babcock and Wilcox chain-grate stoker is given in Fig. 4. The scheme followed in the design consists merely of extending the arrangement indicated in Fig. 1 to its logical conclusion. Thus the shaft A is extended downwards and fitted with a second worm at a point below the worm wheel F. A similar vertical shaft with two worms and a worm wheel is arranged on the near side of the driving shaft. The shaft B is likewise extended and is provided with a second worm wheel. A similar horizontal shaft with one worm and two worm wheels is arranged below the driven shaft. Sliding clutch connections are provided on each side of the worm E and on each side of the corresponding worm on the lower horizontal shaft. The four-speed gear is thus composed of four sliding clutches, seven worms, and seven worm wheels. A simple form of automatic interlocking handle is provided for the control of the four clutches.

The dimensions of the device are quite small, the casing overall measuring only 14½in. by 11½in. by 16½in. Yet in spite of this fact the speed reduction ratios are extraordinarily great, as will be seen from the table given on the general arrangement engraving, Fig. 4. On the first speed the ratio reaches the truly remarkable value of 27,025 to 1, a figure which could not possibly be approached by means of ordinary spur reduction gearing unless it were made with preposterous dimensions.

The design of the four speed and reverse gear for commercial motor vehicles follows the same general arrangement as that just described, except that means are provided for the direct coupling of the driving and driven shafts. When the shafts are so coupled the gear ratio is, of course, unity. Of the remaining four alternative paths for the drive one gives a ratio of 1.75 to 1, another a ratio of 3.1 to 1, and a third a ratio of 4.85 to 1. The fourth gives the reverse drive with a ratio of 4.85 to 1 The reversal of the motion is obtained simply by altering the helix angle of one of the worms D—Fig. 1—and its associated worm wheel G. The particular example to which the figures given relate is designed for the transmission of 50 horse-power at 1000 revolutions per minute.

Among the principal advantages claimed for this new form of reduction gearing is its small size relatively to the reduction ratios given by it. In ordinary spur gearing the reduction ratio required settles in large measure the size

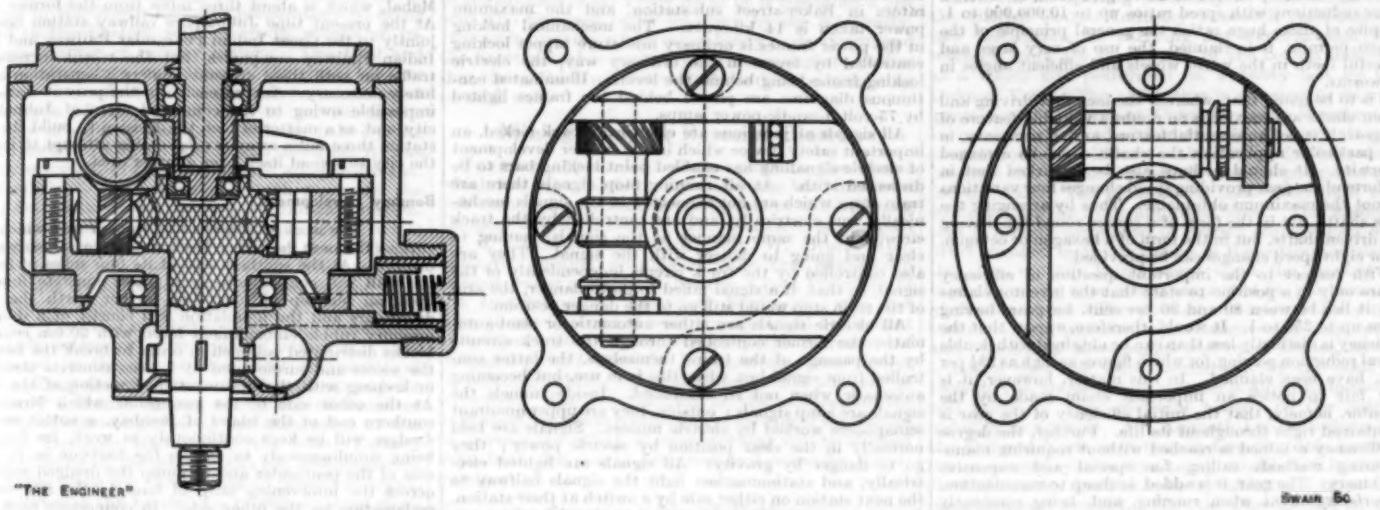
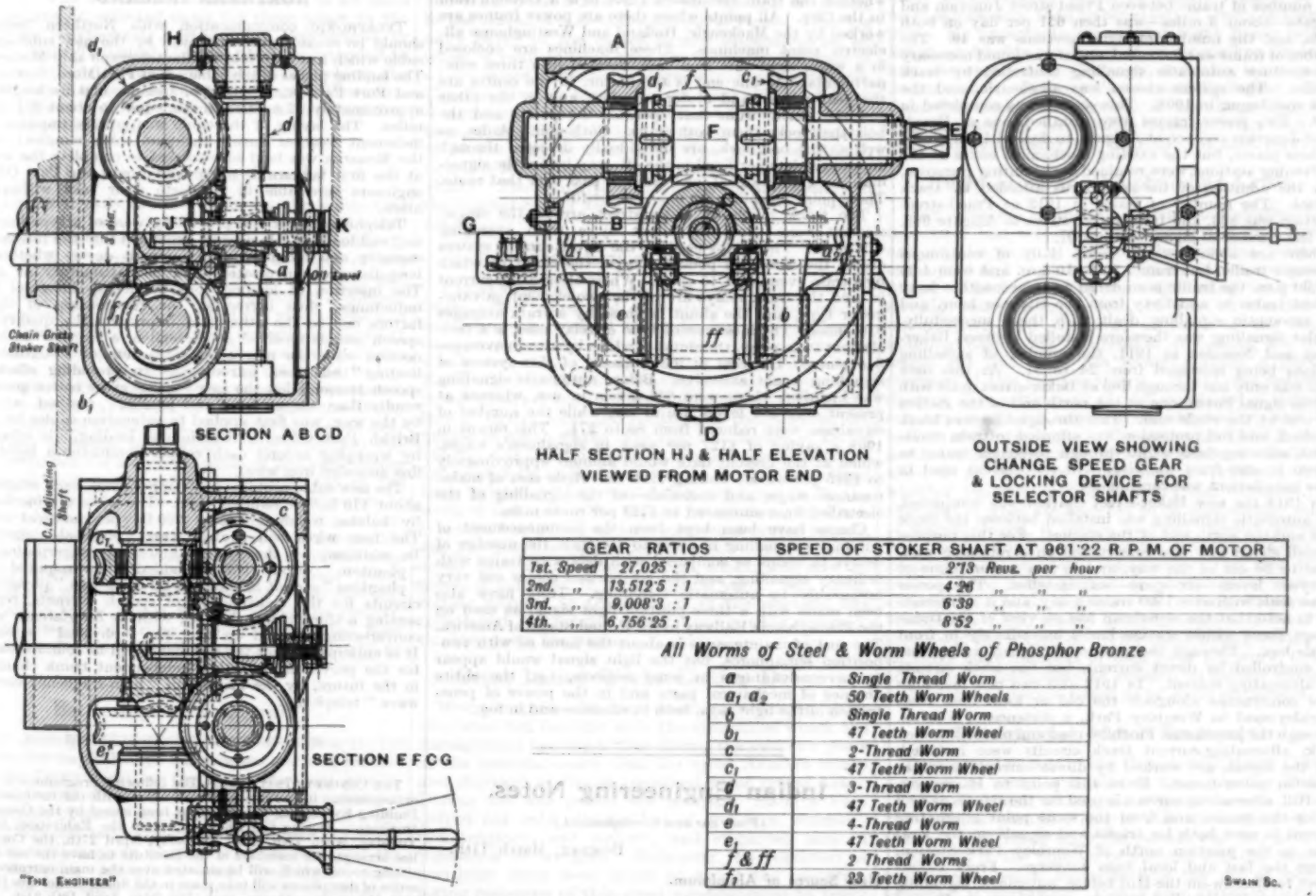


FIG. 3—DETAILS OF GEAR FOR MOTOR CAR STARTING AND LIGHTING SET


SECTION A B C D
HALF SECTION HJ & HALF ELEVATION VIEWED FROM MOTOR END
OUTSIDE VIEW SHOWING CHANGE SPEED GEAR & LOCKING DEVICE FOR SELECTOR SHAFTS
SECTION E F C G
Chain Grate Stoker Shaft
C.I. Adjusting Shaft
"THE ENGINEER"
SWAIN Sc.

GEAR RATIOS		SPEED OF STOKER SHAFT AT 961·22 R.P.M. OF MOTOR
1st. Speed	27,025 : 1	2·13 Revs. per hour
2nd. ,,	13,512·5 : 1	4·26 ,, ,, ,,
3rd. ,,	9,008·3 : 1	6·39 ,, ,, ,,
4th. ,,	6,756·25 : 1	8·52 ,, ,, ,,

All Worms of Steel & Worm Wheels of Phosphor Bronze

a	Single Thread Worm
a_1 a_2	50 Teeth Worm Wheels
b	Single Thread Worm
b_1	47 Teeth Worm Wheel
c	2-Thread Worm
c_1	47 Teeth Worm Wheel
d	3-Thread Worm
d_1	47 Teeth Worm Wheel
e	4-Thread Worm
e_1	47 Teeth Worm Wheel
f & ff	2 Thread Worms
f_1	23 Teeth Worm Wheel

FIG. 4—27,000 TO 1 WORM REDUCTION GEAR FOR MECHANICAL STOKER

of the wheels, so that for large reductions, if unwieldy dimensions are to be avoided, two or more trains of wheels have to be employed. In worm gearing, on the other hand, the speed ratio does not bear any definite relation to the wheel diameter. In Major Hatcher's system as represented in Fig. 1 a reduction to the third power is obtained, namely, once at each of the three sets of worms and worm wheels. We have already mentioned an actual example of the gear in which the ratio is over 27,000 to 1. It is possible, however, we are informed, with the simple gear to obtain a ratio as high as 100,000 to 1. In addition, the gear may be compounded so as to give sixth or seventh power reductions with speed ratios up to 10,000,000 to 1. In spite of these huge ratios the general principle of the system permits, it is claimed, the use of very large and powerful teeth in the worm wheels and efficient angles in the worms.

It is to be noted that, whereas the fact that driving and driven shafts are coaxial is no doubt a valuable feature of the gear, it is not an essential feature, and, if necessary, in any particular application the shafts could be arranged otherwise. It should perhaps also be remarked that in the form of the gear providing speed changes four variations are not the maximum obtainable. Thus by arranging the cross shafts, not in the form of a square round the driving and driven shafts, but in the form of a hexagon or octagon, six or eight speed changes can be provided.

With respect to the important question of efficiency we are only in a position to state that the inventor claims that it lies between 80 and 90 per cent. for gears having ratios up to 250 to 1. It would, therefore, appear that the efficiency is distinctly less than can be obtained with double helical reduction gearing, for which figures as high as 98½ per cent. have been claimed. In this matter, however, it is only fair to notice an important claim made by the inventor, namely, that the initial efficiency of the gear is maintained right throughout its life. Further, the degree of efficiency attained is reached without requiring manufacturing methods calling for special and expensive machinery. The gear, it is added, is cheap to manufacture, is perfectly silent when running, and, being constantly immersed in an oil bath and the tooth pressures being low, has a very high degree of durability.

The Institution of Civil Engineers.

"ALL-ELECTRIC AUTOMATIC POWER SIGNALLING ON THE METROPOLITAN RAILWAY."*

By William Willox, M. Inst. C.E.

In 1905, when electric trains commenced to run on the Metropolitan Railway, the system of signalling was mechanical, controlled by Spagnoletti lock and block. The number of trains between Praed-street Junction and Aldgate—about 5 miles—was then 621 per day on both roads, and the number of signal sections was 49. The number of trains was increased, and it was found necessary to introduce automatic signalling controlled by track circuits. The system chosen was all-electric, and the work was begun in 1908. This section was completed in 1909. Two power frames were installed, one at Praed-street Junction and one at Aldgate, to deal with the traffic at these places, but the existing mechanical boxes at the intervening stations were retained for shunting purposes, with the addition of the safeguards afforded by track control. The number of trains in 1913 at Praed-street Junction was 863, and from Baker-street to Aldgate 983, and the number of signal sections 91.

There are about twenty hours daily of continuous passenger traffic, but from 7.30 to 10 a.m. and from 4.30 to 7.30 p.m. the traffic is so dense as to necessitate forty booked trains to and forty from the city per hour, and the automatic signalling dealt with these successfully. Similar signalling was therefore installed between Baker-street and Neasden in 1911, the number of signalling sections being increased from 24 to 51. At this date there was only one through line at Baker-street dealt with by two signal boxes, one at the north end of the station and one at the circle end. This through line was track circuited, and full protection was afforded to train movements, allowing forty-eight through passenger trains to be run to and from the city. All the current used in these installations was continuous.

In 1913 the new Baker-street Station was completed, and automatic signalling was installed between the circle lines and the north end of the station. For this purpose a small signal box was constructed on a retaining wall, so as to be out of the way, and in it a power frame of thirty-six levers—six spare—was installed. This power frame deals with over 1500 trains a day, and it is interesting to note that the signalman has no view of the trains except those within station limits immediately in front of his box. Through the station all signals and points are controlled by direct current, but the track circuits are alternating current. In 1913 also two new fast lines were constructed alongside the old or local lines from Finchley-road to Wembley Park, a distance of 5 miles. Through the junction at Finchley-road and on to Wembley Park, alternating-current track circuits were installed, but the signals are worked by direct current as far as Neasden power-house. From this point to Harrow-on-the-Hill, alternating current is used for the signals as well as for the tracks, and from the same point alternating current is used both for tracks and signals on the local lines to the junction north of Wembley Park Station, where the fast and local lines converge. From Baker-street to Harrow-on-the-Hill before automatic signalling there were 39 signalling sections, now there are 69, and on the through fast lines there are 20 sections. In 1919 the signalling from Praed-street Station to South Kensington, which was an automatic bar and treadle system controlled by direct current, was track circuited with alternating current, but the signals continue to be controlled by direct current.

Current for the supply of power to operate the power frame at Praed-street Junction and at Baker-street is obtained from two 130-volt 5-kilowatt motor generators through suitable cables. These supply power for the operation of the points, the signal lamps and train stops, the electro-magnets for back locks and for the constant indication of power-worked points at Praed-street Junction, and also for working the power frame at Baker-street, the total required for both boxes being 2.08 kilowatts. For operating the track circuits, automatic and semi-automatic signals, and train stops between Praed-street, Bishop's-road and Edgware-road stations, and also between Edgware-road, Great Portland-street and Marlborough-road, and for the four large illuminated train indicators at Baker-street, power is obtained from one 15-kilowatt and two 12-kilowatt 70-volt motor generators in Baker-street sub-station, and the maximum power taken is 14 kilowatts. The mechanical locking in the power frames is ordinary miniature tappet locking controlled by levers in the ordinary way, the electric locking frame being behind the levers. Illuminated continuous diagrams are placed behind the frames lighted by 75-volt 5-candle-power lamps.

All signals at junctions are electrically back-locked, an important safety device which in the further development of electric signalling has enabled point locking bars to be dispensed with. At all running stop signals there are train stops which are not connected to the signals mechanically, but electrically, and are controlled by the track circuits in the same manner as the signals, coming to clear and going to danger with the signal. They are also controlled by the track circuit independently of the signal, so that, if a signal failed to go to danger, the arm of the train stop would still go to the danger position.

All electric signals are either automatic or semi-automatic, the former controlled through the track circuits by the passage of the trains themselves, the latter controlled from signal box when this is in use, but becoming automatic when not so controlled. Inside tunnels the signals are lamp signals; outside, they are upper quadrant semaphores worked by electric motors. Signals are held normally in the clear position by electric power; they go to danger by gravity. All signals are lighted electrically, and stationmasters light the signals halfway to the next station on either side by a switch at their station. One hundred yards behind each stop signal in the open, fog repeater signals have been erected, the lights of which are placed at the level of the driver's eyes and as near as possible to the running line. By this means an indication is given to the driver whether the stop signal ahead is at clear or at danger, and if at danger he can slow up and avoid being tripped suddenly. The signalmen have fog repeater switches in the signal box, by means of which they can light the fog repeater lamps when necessary.

Between junctions it is possible to have a number of trains—*e.g.*, between Finchley-road and Baker-street it is possible to have ten trains—and Mackenzie, Holland and Westinghouse Company's magazine train describers were installed, by which the signalman at Finchley-road is enabled to indicate to the Baker-street signalman whether the train terminates there or is a through train to the City. All points where there are power frames are worked by the Mackenzie, Holland and Westinghouse all-electric point machines. These machines are enclosed in a water-tight cast iron case, divided into three compartments. At one end is the motor, in the centre are the gear wheels and motor switches, and in the other end the worm drum that operates the points and the bolt that locks them both ways. Both point blades, as well as the bolt lock, are individually detected through an electric detector fixed in the 4ft. way before the signalman can get his signal for a train to pass over that route. These point machines are most successful.

The track relays at Baker-street are of the single-element vane type, the shunt by a train averaging 0.9 ohms. The relays used on the direct-current system are of the three-coil polarised type, the shunt of which by a train averages 0.15 ohms. Where alternating current is used the track relays are of the two-element galvanometer type, and the shunt of these by a train averages 0.6 ohms. The most recent type of relay used is a two-element vane relay, the shunt of which by a train averages 3.4 ohms. The cost of maintenance of this system of signalling is not excessive. Before automatic signalling was installed, there were 645 levers in use, whereas at present only 311 levers are in use, while the number of signalmen were reduced from 86 to 27½. This meant in 1908 a saving of £127 per week in signalmen's wages, which at the present date would amount approximately to £325 per week. During 1920 the whole cost of maintenance—wages and materials—of the signalling of the electrified lines amounted to £123 per route mile.

Charts have been kept from the commencement of automatic signalling in order to ascertain the number of delays to trains as compared with delays to trains with ordinary signalling, and the comparison comes out very favourably to automatic signalling. Tests have also been made with a three-position light signal as used on the Pennsylvania Railway in the United States of America. The cost of maintenance is about the same as with two-position semaphores, but the light signal would appear to have advantages in some respects, *e.g.*, the entire absence of mechanical parts and in the power of penetration of the light rays, both in sunshine and in fog.

* Official abstract of a paper read before the Institution on Tuesday, March 21st, 1922.

Indian Engineering Notes.

(*From our own Correspondent.*)

Bombay, March 11th.

New Source of Aluminium.

For some years it has been known that the Central Provinces of India have contained considerable quantities of bauxite, but recent surveys indicate that the ore in sight is very much larger than was anticipated. Hitherto the obstacle in the way of developing these deposits has been the lack of power, but Government is now taking an interest in the proposal to erect a large hydro-electric installation in the Chhindwara district, and if the scheme is carried into effect the aluminium industry will be commenced on a large scale. Incidentally the by-products remaining after the extraction of the aluminium are extremely valuable for use in the manufacture of fertilisers, and in this phase of the subject a Paris financial syndicate is said to be taking a more than passing interest. The scheme would entail the construction of an electric transmission line more than 150 miles in length, and the erection of a wide variety of mills and factories, which would probably be situated in the neighbourhood of Jubbulpore.

New Railway Terminus.

Mention of Jubbulpore reminds me that the Great Indian Peninsular Railway is credited with the intention of erecting a large terminal station at Madan Mahal, which is about three miles from the former city. At the present time Jubbulpore railway station belongs jointly to the Great Indian Peninsular Railway and East Indian Railway companies, but the recent increase of traffic on both these systems renders a separation absolutely necessary. Any extension of the present station is impossible owing to the congested state of Jubbulpore city, and, as a matter of fact, the decision to build the new station three miles away is a far-seeing attempt to induce the city to spread itself over a larger area.

Bombay Development.

The work of constructing the sea wall which will enclose the new Back Bay Reclamation has already commenced. At the southern end of its four miles of length the wall will consist entirely of mass concrete founded upon an outcrop of rock, but farther north the rock disappears and the foundation will consist of a dumped masonry rubble embankment faced with 20-ton concrete blocks distributed pell-mell in order to break the force of the waves and surmounted by a mass concrete structure in keeping with the first-mentioned section of the wall. At the other side of the peninsular which forms the southern end of the island of Bombay, a cutter suction dredger will be kept continuously at work, its function being simultaneously to deepen the harbour on its own side of the peninsular and to pump the dredged material across the intervening strip of land to the site of the reclamation on the other side. In connection with this reclamation scheme the Government of Bombay has opened its own quarries at Kandivlee, about 20 miles from the site, and has installed a complete plant of the most modern quarrying machinery. The quantity of masonry which will be used in the construction of the sea wall will itself be enormous, but the supplies at the quarries are believed to be practically inexhaustible, and it is anticipated that they will be able to supply all the stone required in Bombay for many years to come.

TELEPHONIC COMMUNICATION WITH NORTHERN IRELAND.

Telephonic communication with Northern Ireland should be considerably improved by the new submarine cable which has been laid by the telegraph ship Monarch. The landing places of the cable are at Port Mora, Scotland, and Port Patrick, Donaghdee, Ireland, and its length is approximately 22 nautical miles, equal to about 25½ land miles. The laying of the cable was greatly impeded by inclement weather during the past three months; but the Monarch was held in readiness to complete the work at the first favourable opportunity, and the Post Office engineers were able to complete their task without a hitch.

Telephone cables laid previously were of a type known as "coil loaded." It may be explained that the resistance capacity and inductance of a circuit decide whether a long-distance conversation will be satisfactory or not. The insertion of loading coils artificially increases the inductance, thus correcting the relationship of these factors one to the other and improving the quality of speech sounds received at the end of a circuit. In connection with the new cable, a system of "continuous loading" has been introduced. In providing effective speech transmission the new system gives better general results than the earlier "coil loading" method, which, by the way, was first applied to submarine cables by the British Post Office. "Continuous loading" is effected by wrapping around each copper conductor a layer of fine annealed iron wire.

The new cable contains four copper wires, each weighing about 170 lb. per nautical mile. The wires are insulated by balata, weighing nearly 200 lb. per nautical mile. The four wires will provide two "physical" circuits. In addition, by the system known as superposing, a "phantom" circuit will be added when required. A "phantom" circuit is obtained by using two "physical" circuits for the transmission of speech currents, representing a third trunk channel, without interference with conversations carried on over the "physical" circuits. It is anticipated that the new cable will be found suitable for the provision of further independent trunk channels in the future, by the method of "high-frequency carrier wave" telephony.

The Concrete Institute.—The following programme of the arrangements it has made in connection with the forthcoming Building Exhibition, Olympia, has been issued by the Concrete Institute:—During the whole period of the Exhibition, from Tuesday, April 11th, until Thursday, April 27th, the Council has arranged for members of the Institute to have the use of a sitting room, which will be situated over the main entrance. A series of discussions will take place in the Small Conference Hall, over the main entrance, each day from April 18th-21st. On Tuesday, April 18th, the subjects will be (*a*) "Training the Concretor," and (*b*) "Recent Developments in the Industry." The discussions on both will be opened by Mr. E. Fiander Etchells (President). On the Wednesday there will also be two subjects, (*a*) "Concrete Roads," and (*b*) "Use of Reinforced Concrete in Highway Bridges," and the discussion on them will be opened by Dr. Oscar Faber. The subject for the Thursday is "What Life can be Assigned to Works of Reinforced Concrete for the Purpose of Government Loans?" The discussion will be opened by Mr. G. C. Workman. For the Friday there are three subjects, (*a*) "Concrete Block Building"; (*b*) "Reinforced Floors"; and (*c*) "Use of Pre-cast Work in Building Structures"; and the discussion on them will be opened by Mr. E. S. Andrews.

A Seven-Day Journal.

Passing of the Hull and Barnsley.

THE absorption of the little Hull and Barnsley Railway in the North-Eastern, preparatory to being merged in the Eastern railway group, recalls an interesting chapter of railway history. The Hull and Barnsley came into existence in the year 1885 as the result of an effort on the part of those interested in the trade of the port of Hull to get rid of the monopoly of railway and port facilities held by the North-Eastern Railway, which had resulted, it was roundly asserted, in a failure to give adequate transport facilities. The newcomer, which possessed the Alexandra Dock as well as a local railway system, was at once subjected to a rate war, which, while it attracted trade to the port, forced the Hull and Barnsley into the hands of a receiver. The company survived this trying period, and in a reorganised form continued to dispute the monopoly of the North-Eastern. The relations between the two companies afterwards entered a more friendly phase, and they co-operated in the construction and equipment of the new King George Dock, which was opened for traffic only a month or two before the outbreak of war. Those who objected to the absorption of the Hull and Barnsley Railway by the North-Eastern Company did so on the ground that the amalgamation would again place the port of Hull in respect to transport facilities in the hands of a monopoly even more powerful than that which was broken when the Hull and Barnsley was formed.

Scholarships in Engineering.

CONDITIONS are now announced for the scholarship in civil engineering for which a sum of money was bequeathed to the London County Council by Sir Archibald Dawnay. Under the scheme which has just been approved one scholarship will be awarded each year to candidates between sixteen and eighteen years of age who have passed or are exempt from the matriculation examination of the University of London. The scholarship will be tenable in all cases for two and in selected cases for three years in the Battersea Polytechnic, Northampton Polytechnic, or the Finsbury Technical College, but it is intended to approve other technical institutions at which the scholarship may be held in future years. The maintenance grant is £110 a year, out of which tuition fees will require to be paid.

The New German Canal.

FURTHER details are available on the subject of the proposed canal between the Ruhr industrial region and the Lower Elbe and Weser. The Hansa Canal, as it is termed, would have a length of 349 kiloms. to Oldenburg, 384 kiloms. to Hamburg, and 523 kiloms. to Lubeck. Besides providing a connection between the Ruhr basin and the rivers Elbe and Weser, it would give Lubeck good waterways transport westwards, and place Hanover in touch with North Sea ports. There are no engineering difficulties of any magnitude, and very few locks would be required. The new waterway would be carried over the Weser valley on a dam about 10 m. high, and be carried over the Weser at Achim by a bridge. The estimated cost of construction for a canal capable of accommodating vessels of 4000 tons deadweight is from 115 to 120 million gold marks. In view of the low value of currency in Germany at the present time, it is anticipated that contracts could be placed on favourable terms, and that an annual traffic of 8 million tons would suffice to cover working expenses, maintenance and interest on the capital involved. Government aid is to be sought for this ambitious project, but the interest of strong financial groups has been secured, and it is believed that the capital will be found.

Battleships and Aircraft.

THE anticipated early placing of contracts for the two new capital ships has aroused a strong protest from Sir Percy Scott on the waste involved in constructing units which, he asserts, will be useless for the purpose of naval operations in time of war. The gallant admiral reiterates the now familiar argument that the surface-going warship is at the mercy of the bomb-dropping aeroplane, and challenges naval architects to design and shipbuilders to construct a warship which will remain afloat after the explosion of "5000 lb. of T.N.T. five yards away and at a depth of 10ft. beneath the surface." These, he contends, are the conditions of future war on battleships, and ridicules the statement of a naval officer that a battleship can only be destroyed by a battleship. In Captain Guest, who, in the House of Commons, drew a picture of the Air Service superseding the Army and Navy, Sir Percy Scott has found a new champion of his cause, and although the Minister for Air has not the advantage of being a sailor, Sir Percy has risen up and called him blessed. Mr. Amery, representing considered naval opinion, will, of course, have none of these heresies. He puts forward the argument that battleships are still the pivot of naval warfare, and in the opinion of Sir Percy Scott he is therefore a lost soul who has been badly let down by the Admiralty. It is a controversy which is not likely to die down, and the Scott school is probably astute enough to realise that time, which will solve all these doubts, is fighting on their side.

Mining Dangers Research Board.

GENERAL approval has been given to the choice which has been made by the Secretary for Mines of a Sub-committee on Technical Appliances of the Mining Dangers Research Board. The nominees are Colonel W. C. Blackett (chairman); Mr. W. Brace, who, until he became an official, was the well-known Labour leader; Mr. C. P. Sparks, a past President of the Institution of Electrical Engineers, who has been closely associated with the electrical equipment of mines; Dr. R. V. Wheeler, the Director of Research; and Mr. C. D. Mottram, the Senior Inspector of Mines. The last-named will also act as secretary. The composition of the sub-committee indicates that the investigation of technical appliances to increase the safety of mine working will be studied from both the purely practical and scientific standpoints.

American Naval Policy.

FEARS are being aroused in United States navy circles that the too literal interpretation of the Washington agreement may leave the American navy in a position of inferiority to the navies of Great Britain and Japan. There is a widespread belief that if these nations maintain the *personnel* of which figures have been given there would be a considerable reserve of trained officers and men after all the ships allowed under the agreement were manned, whereas should the reduction of the American *personnel* be on the lines suggested, several capital ships and other war vessels would go out of commission for lack of crews, and the United States would run the risk of sinking to the status of a second-class naval Power. The big navy party in the States is now impressing on all whom it may concern that the strength efficiency of a navy is not measured in ships only, but in *personnel*. The President is apparently on their side, and there is a growing belief that with his aid the recommendations of the Naval Affairs Committee for a *personnel* of 86,000 may be accepted. The proposed British figure, it is pointed out, is 117,758, and that of Japan 73,252. The contentions of the strong navy party in the United States are not wanting in either force or reason.

Trade Union Restrictions.

FRESH evidence is to hand of the extent to which trade union rules and regulations are not merely restricting the revival of trade, but are sending it to a lower depth of depression. The facts are worth recording. A Leith firm of ship repairers, Henry Robb, Limited, having obtained a large repair contract from a Cardiff shipowning firm in the face of strong local and continental competition, are unable to get to work. The ship was docked at Leith, but the managing director of the firm states that the job cannot be started because the local boilermakers have insisted on four men being employed to do the work of two men. The repairs on another vessel are, it is said, being held up for a somewhat similar reason, and the firm has had to decline a new contract which could have been obtained, and which will now be given, it is feared, to a continental yard. Mr. Robb, rightly angered at the attitude of the workers, has threatened, if this futile policy is not quickly reversed, to close down his works.

Great Italian Works Closing Down.

MUCH surprise has been occasioned among those who were not familiar with the difficulties which the management has had to face during the past two years at the announcement that the great Ansaldo works and shipyard at Genoa are about to be closed down. During the war period the company made a huge output not only of ships but of ordnance, ammunition, engines, and aircraft, and employed tens of thousands of workers. Following the cessation of hostilities steps were taken to divert the manufacturing resources of this great establishment to peace trading requirements, but Communist activities, excessive war taxation, and other troubles have proved almost insuperable obstacles. It is stated that the majority of the men employed have opposed the Communist element and have been willing to co-operate with the directorate in the change over from war to peace production. A crisis has now, however, been reached—mainly financial—and the new directors—the original board having resigned soon after the war—is making a final appeal to the Government in order to prevent the closing of the establishment and the widespread unemployment which must be associated with such an event.

Shirley Institute.

THE official opening ceremony in connection with the British Cotton Industry Research Association's new institution for carrying out experimental and research work for the benefit of the cotton industry as a whole was performed on Tuesday last by the Duke of York. The institution is situated in its own grounds of 14½ acres at Didsbury, near Manchester. It comprises an administrative block—including a council room and library—laboratories for botanical, physical and chemical research, workshops and houses for the staff. The laboratories have been built and equipped on the most approved lines. The Association is a body comprised of British corporations and firms engaged in any branches of the cotton industry, the subscriptions being based upon the amount of capital for the time being employed in the business of the members. The Council consists of thirty-two members, and includes representatives of employers' and operatives' associations and other bodies, and it is hoped that the work carried out by the staff at Didsbury in showing how science is allied to industry will prove of very material benefit to the cotton industry as a whole. Mr. Kenneth Lee, in welcoming the Duke of York, said that in founding this institution a necessary link was being established between the Universities and the industry which has, up to the present, never existed. He said they looked to the Shirley Institute in the future to assist by its discoveries in solving the problems of poverty and unemployment and to lead to an era of prosperity.

Commercial Air Transport.

THE entry of the Daimler Company into the London-Paris air service is an encouraging development, and advantage was taken by the Postmaster-General, at a luncheon to celebrate the event, which was held in London on Wednesday, to bless what he termed an "audacious" enterprise. Mr. Kellaway emphasised the great importance of reliability in air travel, which he rightly regards as of more significance than either speed of travel or cheapness. He expects to see regular night flying established, and holds out hopes of an air mail to Brussels and thence through Germany, and also by way of Amsterdam to Prague, Vienna and Budapest. The Cairo-Baghdad mail service, it has been claimed, demonstrated in remarkable fashion what can be achieved by utilising the air route for mail services.

Engineering and Shipbuilding Crisis.

THE situation in the engineering and shipbuilding industries has not improved during the past week, and at the time of writing the disputes between employers and workers are drifting into a menacing phase. The lock-out in the engineering trades has already placed a large body of men on the list of unemployed, and the firm attitude of the Shipbuilding Employers' Federation in making the first wages cut this week has brought about a partial stoppage of this great industry. It will be a national disaster if a settlement of the questions in dispute is not reached as the result of the negotiations and the ballots now in progress. The issues involved in connection with the extent to which workers should be allowed a voice in management problems—and whether the shipbuilding industry can continue the payment of what are asserted to be uneconomic rates of wages—ought, if reason and not passion prevail, to be settled on terms honourable to both sides and in keeping with economic conditions. The fact that notices have been posted to members of unions outside the A.E.U., which are to become effective on Wednesday next, should bring matters to a head in the case of the engineers. In the shipbuilding industry, although large numbers of men have left work, there are signs of differences of opinion in labour circles, and on this hopes are based of an early settlement.

Commercial Motor Transport.

THE annual parade of the Commercial Motor Users' Association, which was held at Lincoln's Inn Fields on Saturday last, was again a great success. Over 200 vehicles paraded, and it was the largest entry that has been made since the parade was first held in 1910, both in the number of vehicles and the owners represented, which indicates how the use of motor transport is increasing. Points were awarded to each vehicle according to its general condition and the mileage it had completed, and after a lengthy inspection by an expert tribunal of judges, the challenge cup and first prizes were awarded to the team of three Thornycroft vehicles entered by Thomas Wethered and Sons, Limited. Each of the winning trio had completed over 30,000 miles in the regular service of its owners, who are engaged in the brewing industry. The second prizes were won by a team entered by Shell-Mex, Limited, which won the cup in 1921, with a mixed team of Thornycroft and other vehicles. The parade was an admirable illustration of the way the modern motor lorry stands up to its work.

Institution of Mechanical Engineers.

BRITISH AND AMERICAN LOCOMOTIVES.

The discussion of Mr. P. C. Dewhurst's paper on "British and American Locomotive Design and Practice," which was begun at the Institution of Mechanical Engineers on March 17th, was resumed on the 24th inst., under the chairmanship of the President, Dr. Hele-Shaw.

The discussion was opened by Mr. A. E. L. Chorlton, who said that the chief interest in the paper, from his point of view, lay in the opportunity which it provided for considering the application of locomotive engineering practice to other branches of engineering. One of the most striking features in which British and American practice differed was in the size of the boilers, a contrast which had not yet been really satisfactorily explained. The British designer pleaded that he could not use larger boilers on account of the limitations imposed by the loading gauge; but to a man not fully conversant with locomotive work it appeared that the designer did not always take full advantage of those limits. Thus there was, on the Great Western Railway, a locomotive which had a grate area 25 per cent. larger than that of the normal engines, and it was difficult to understand why, if it could be done in one case, this increase in capacity could not be carried out generally. Mr. Chorlton commented on the lack of information in the paper as to the use of special steels in the construction of locomotives, and suggested that their adoption might materially reduce the stresses imposed upon the working parts by inertia effects as they reciprocated. On the Pennsylvania Railroad such a policy had been followed, and had made it possible to increase the axle load considerably beyond the 20 tons limit previously imposed. In this connection he asked if it was the practice on English railways to consider the axle load as dead load only, or to include in it the live load produced by the acceleration of the moving parts of the engine.

Mr. J. D. Twinberrow drew a comparison between the stability of a locomotive running on rails and that of a ship at sea, in which the support given to the engine by its springs corresponded with the righting moments of the ship. He showed how a locomotive has a metacentric height, just as a ship has, and how a great metacentric height produced a stable locomotive, but, at the same time, caused uneasy running, as the righting force which tended to bring the engine back into the normal position after it had been deflected from the vertical was too powerful. There were several ways of overcoming this trouble, such as bringing the springs closer together or raising the centre of gravity, but care had to be taken not to produce a negative metacentric height, or the engine would be unstable. The conditions of a locomotive as regards fore and aft stability were very much the same, only on a larger scale, and the best way of controlling the pitching of an engine was to have separate springs to each pair of wheels. Such an arrangement, however, concentrated the axle loads and was too hard on the track. On the other hand, if compensating levers were put in to equalise the load on all the springs, there would be no fore and aft stability. The best way, in fact, the only way, to arrange the compensating gear was, according to Mr. Twinberrow's ideas, to divide it into two sections, so that the load was equalised on two groups of wheels. Continuing, Mr. Twinberrow said in discussing the relative merits of plate and bar frames the author had considered them both as complete units in themselves, but it should really be borne in mind that the bar frames used in America secured great assistance in the way of lateral rigidity from the boilers. The plates used to transmit the weight of the boiler to the frames were light enough to permit the longitudinal expansion of the boiler, but transversely they made a very strong connection between the several members, and the boiler was, of course, immensely stiff. Mr. Twinberrow quite agreed with the policy of making the frame as stiff as possible, and pointed out, as an example of rigid plate frame construction, the old-fashioned British six-coupled engines in which there was a wide footplate running the length of the frames on the outside. The combination of the footplate and the frame plate made a very stiff girder. In some of the later engines parts of the footplate were cut away to clear the wheels, and no metal was added elsewhere to compensate for the loss. These later frames cracked, showing that the horizontal forces had stressed the plates beyond their elastic limit. Mr. Twinberrow could not see how the position of the cylinders on the frame could have any influence on the "nose-ing" of locomotives, at comparatively low speeds at any rate, as the couples of forces between the crank pins and horn cheeks were balanced. If the connecting-rods were short, however, the reaction of the crosshead on the slides would tend to lift the engine, and with a three-point suspension bogie it would be liable to "shoulder." Three-point suspension was, however, seldom used for high-speed engines, as it produced uneasy running. In discussing bogies, Mr. Twinberrow said that their lateral control should be made aperiodic by using coiled springs in which each coil came home on the abutment independently as it was collapsed.

Mr. W. P. F. Fanghaenel said that he had had experience in the shops erecting locomotives both in this country and in America, and the fundamental difference in practice which struck him most was that whilst British engineers started work by erecting the frame, the American scheme was to put down the cylinders first and build the rest of the engine on to them. This difference is, of course, to a large extent accounted for by the fact that the two American cylinders, together with the intervening saddle, are in two castings only, which forms a very rigid and wide base from which to commence lining up. Mr. Fanghaenel made some sketches on the blackboard to illustrate the weak points in bar and plate frames. In bar frames fractures generally occurred where the section was changed abruptly at the connection between the cylinder casting and the frame and just beyond this point in the first horn opening. With plate frames failure sometimes took place where the horn plates are attached to the frame, and was accounted for by rough treatment while the hornstay was being put in place. He agreed with Sir Henry Fowler that it was bad policy to use steel fire tubes in locomotive boilers, specially in conjunction with copper fire-boxes, and pointed out that one of the probable reasons why they were more popular in America was the possibility of welding them into the steel tube plate. A thin copper ferrule was slipped in between the tube and the plate, and the end of the tube was then welded over on to the plate. It was quite easy to get these tubes out again, if necessary, after the welding had been cut away, and it was not nearly so detrimental to the tube plate as the continued use of that barbarous tool, the tube expander, on a copper plate. He considered that the small smoke-box door used in America must make it very difficult to remove some of the tubes, unless they were such a slack fit in the holes in the tube plate that they could be canted over to reach the door.

Mr. George Watson asserted that the real reason why larger and more powerful locomotives are not used in England was the limit imposed by the strength of couplings and the length of the sidings, which could not accommodate the longer trains that would be the natural outcome of larger engines. The arrangement of such trains so that they could be sorted and the trucks uncoupled at their various destinations would also be a very troublesome problem. He remarked upon the fact that Mr. Dewhurst had not mentioned mechanical stoking, which had been used to some extent in America. He thought that the locomotive fire-box might be improved greatly with the object of increasing the efficiency of combustion. The grate was so low down and so confined that the stoker could not properly attend to the fire and could only clinker it at rare intervals. Outside fire-brick fire-boxes had been used in Belgium, but Mr. Watson did not know if they were still in service. In any case he thought it a pity that locomotive designers adhered so slavishly to the water-space fire-box.

Mr. G. V. O. Bulkeley, Great Western Railway, emphasised the merit of the suggestion put forward by Mr. Dewhurst that the best locomotive can only be evolved by a combination of the best points in both British and American practice. Mr. Bulkeley thought, however, that such a state of affairs was already well on the way towards realisation, and he gave a long list of features in the British-built Great Western locomotives which closely followed American designs. The most marked difference between the practice of England and America was to be found in the valve gears. With the Walschaerts' type of gear used in England the travel of the slide valve was practically limited to 7in., whereas in America valve strokes as long as 9in. were common. It was thus possible to have the exhaust port at one end of the cylinder full open whilst the steam port at the other end was ¼in. open. In discussing the stresses set up in locomotive frames by passing round curves in the track, Mr. Bulkeley described some trials made in Canada with Mallett articulated locomotives. These engines had to work round 15-deg. curves in the Rockies, so an experimental track to try them on was laid down in one of the Canadian Pacific yards. This track was laid with 100 lb. rails, but even with such strong metals they were repeatedly broken off short by the engine until the rounding gear had been adjusted with the greatest nicety.

Mr. H. P. Renwick, Great Indian Peninsula Railway, described some experiments which he had made with blast pipes in India. One of the engines originally had a blast pipe with an opening 4¼in. in diameter, but after several alterations had been tried it was found that the best result was obtained with an orifice 6in. in diameter in which there were three wings, that had much the same effect in roughening the blast as the partial bridges used in America.

Mr. James Clayton, South-Eastern and Chatham Railway, disagreed with the author's suggestion that more eight and ten-coupled locomotives could be used with advantage in England, as the concentrated load they represented was too severe on the bridges, while the drawback against the employment of larger trucks was the capacity of the terminal facilities, such as docks, wharves, &c. The obvious cause of the "nose-ing" of some engines was, he said, the outside position of the cylinders. There were still at work on the South-Eastern and Chatham some locomotives with the old-fashioned round-topped fire-boxes, but there was a tendency to adopt the Belpaire type. The alternative of using a flat-topped fire-box in a round-topped shell was, he thought, bad practice, as when the two were stayed together they could not properly accommodate themselves in expanding and contracting. Mr. Dewhurst had said that he would like to see drop grates applied in England. As a matter of fact, they had been tried on both the Midland and the Great Western, but had been given up again as being unnecessary and unsatisfactory. The reason why pilot valves are used on the regulators of British engines is the difficulty in finding accommodation for a lever sufficiently powerful to open a plain regulator, while the pull-out lever was not in favour here on account of its dangerous character. A locomotive fitted with such a regulator lever once hit the buffer stops, in Scotland, and the jolt threw the lever into the open position, with the result that steam was admitted to the cylinders again. The train was wrecked and many lives lost. In connection with superheaters, Mr. Clayton said that he had found no difficulty in keeping the joints steam-tight, and used a copper ring for the purpose, having a V groove cut in both faces. Dampers were not necessary for the protection of superheaters, but on the South-Eastern and Chatham Railway automatic air inlets to the cylinders were used and came into action when the engine was coasting. The American style of small smoke-box door was, he thought, bad, as it prevented the tubes being cleaned from the front, and if they were cleaned from the fire-box end not only was the job delayed until the boiler had cooled down, but it was also bad practice, as it tended to jam the cinders tighter into the superheater flue tubes. The chief consideration which should be taken into account in proportioning blast pipes was that they must be designed to suit their chimneys, and they should be of such a size that they left an annular space of 1¼in. to 2in. wide between the column of steam and the chimney. It was satisfactory to note that under the thirty-two headings into which Mr. Dewhurst had divided his subject he agreed with British practice in eighteen cases.

Major P. J. Cowan made some remarks on the relation between the size of the fire-box and the style of the main frames, and showed, by means of a sketch, how the American designers get sufficient wearing surface in the horns for the shoes, by adding a separate widening piece. As to their crank pins, they were now so big that trouble was sometimes experienced through high rubbing speed. In this connection it was noteworthy that floating bushes were being used in America for crank pins, side rods, and big ends. These bushes were grease lubricated and naturally ran rather warm, so an allowance of one-sixty-fourth of an inch was generally made on their outside diameter. They were, of course, much cheaper to manufacture than squared brasses, while they had a life about five times longer than that of fixed bushes.

Major C. E. Williams, Crown Agents for the Colonies, pointed out that the Crown Agents were in a good position to compare the relative merits of British and American locomotives, as they had had actual experience of both. He quoted the reports of colonial engineers, which showed that British engines were to be preferred on account of their good workmanship and economy in running and maintenance. On the other hand, price and delivery were in favour of the American machines. The Government once purchased ten locomotives in America for the Crown Colonies, and gave the manufacturers as free a hand as possible in the way of design. These engines were put to work alongside British locomotives, and records made of their performance. The railway engineers were broadly in favour of the British engines, saying that they were better from a mechanical point of view and had a lower fuel consumption than the Americans in the ratio of 78 to 84. The oil consumption was, however, in favour of the American engines. Major Williams said that in his opinion the best practice of the contract locomotive shops in this country was less conservative than that of the works owned by the railways themselves, and for this reason they were more likely to conform to the requirements of the Colonies. In fact, if they were given a free hand they would adopt for such services many features which were considered as being typical American practice. Summing up, he thought that American locomotives were built to sell, and were made on more or less wholesale production lines, while British engines were built to last.

Mr. E. White asked how it was that if the Great Western Railway could employ heavy engines in the days of the broad gauge it could not do so still, while Professor P. M. Baker pointed out that one objection to large trucks was that they could not safely be coupled up in a mixed train with standard wagons.

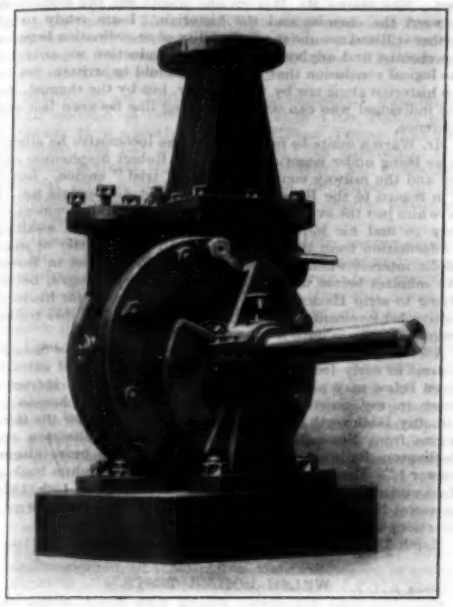
Dr. Hele-Shaw then asked Colonel Kitson Clark to reply to the discussion.

Colonel Clark agreed with Mr. Chorlton that the subject of axle loading is a most important one, and said that the effect of the unbalanced forces of a locomotive running over bridges was now being investigated in India. In Austria, he said, some of the engines had their boilers perched up so high, with the fire-boxes altogether above the frames, that their centre of gravity was 10ft. from the rail level. The object aimed at was not to find room for a large fire-box, but to make all the stays accessible. These engines rode very easily. He forecasted the day when locomotives would be made almost entirely of rustless steel, so that the trouble and expense of painting would be done away with, and alluded also to the use of roller bearings.

A Pump for Powdered Coal.

In view of the large amount of attention which is being given just now to the use of powdered fuel, the pump shown in the accompanying illustrations is of topical interest. It is being made by Pulco Supplies, Limited, of 29, Great Pulteney-street, W., and has been specially devised for handling pulverised coal and similar powders in much the same manner as if they were liquids.

As will be seen from the sectional drawing the pump is extremely simple in form, and has only two interior



PULCO POWDERED COAL PUMP

moving parts—the elliptical rotor and a flap which separates the inlet from the discharge branch. The flap is actuated by an external cam and roller, which can be seen in the half-tone engraving. This type of pump is not, of course, altogether novel, but it is claimed that its use for such a purpose is comparatively new.

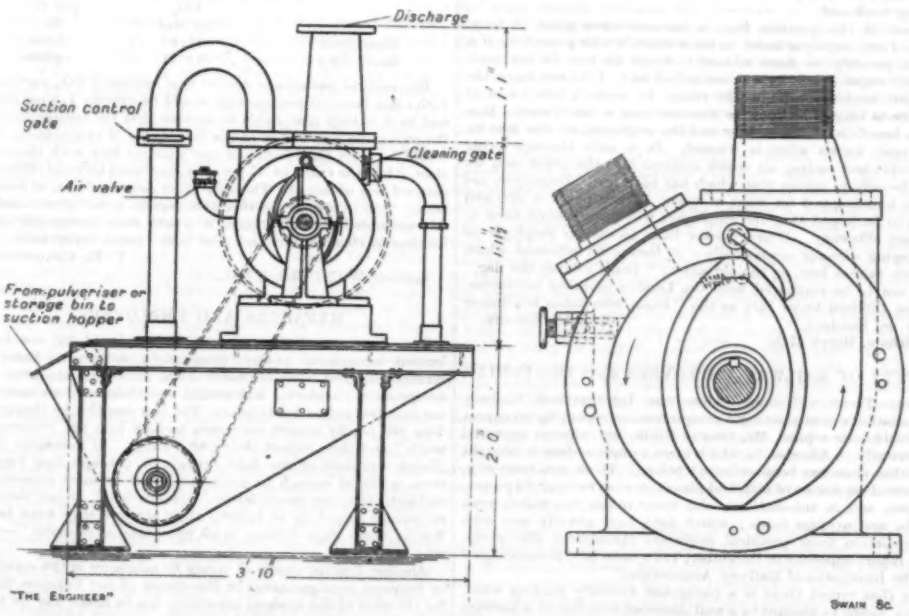
The general arrangement of a plant for pumping powders up to distances of 200ft. and through any reasonable lift is shown in the drawing. The material is delivered into the hopper in the framework, and is prevented from packing together into a solid mass by means of an agitator driven off the pump shaft. The pump sucks the powder out of the hopper by an inverted syphon and a certain proportion of air is mixed with it in the pump. The extent of this addition is regulated by a snifting valve, which can be seen near the pump inlet. The pump is driven at a speed of about 150 revolutions per minute by any convenient motor.

It is claimed for the Pulco pump that it is cheap in first cost, easy to install, low in maintenance cost, that it is capable of doing the work of an elevator at a considerably lower cost when handling suitable materials, and that for the transport of suitable materials to any practical horizontal distance it will compare most favourably with any other existing system at much lower initial expense. Wear is allowed for in the pump design, and all parts can be skimmed up in the lathe when necessary, with the exception of the scraper, which has a large tolerance for wear and can be renewed for a few shillings when completely worn out.

The following figures have been supplied to us by the makers as the average of some tests carried out on pulverised coal:—Pump size, 4in. delivery, 3in. suction. Owing to restricted head-room the total head was only 16ft. Speed of pump, 150 revolutions per minute; fineness of coal, 90 per cent. through a 100 mesh; weight per cubic foot, 39 lb.; moisture content, 7 per cent. approximately; pounds per minute, 200; vacuum, working, 8in. mercury; vacuum, closed, 22in. mercury; volumetric efficiency, 44 per cent.; electrical horse-power, 2.4.

The makers of this machine do not claim to pump any powdered material, as the abrasive action in some cases is too severe, as, for example, in the case of cement. The specific gravity of the material to be pumped has also to be taken into consideration in certain cases, in such a material, for instance, as sulphate of barytes, which is particularly heavy and is difficult to keep in a fluffy state.

Materials such as pulverised coal, powdered lime, flour, powdered limestone, fuller's earth, French chalk, are among those that can be pumped with certainty, whilst other suitable materials in other forms than in powder are the following:—jam, chocolate, sugar, tar, sewage, fuel oil, &c. &c. In pumping thin liquids an air vessel is needed to damp the pulsations of the pump, which in the case of dry powders do not affect the working in any way.



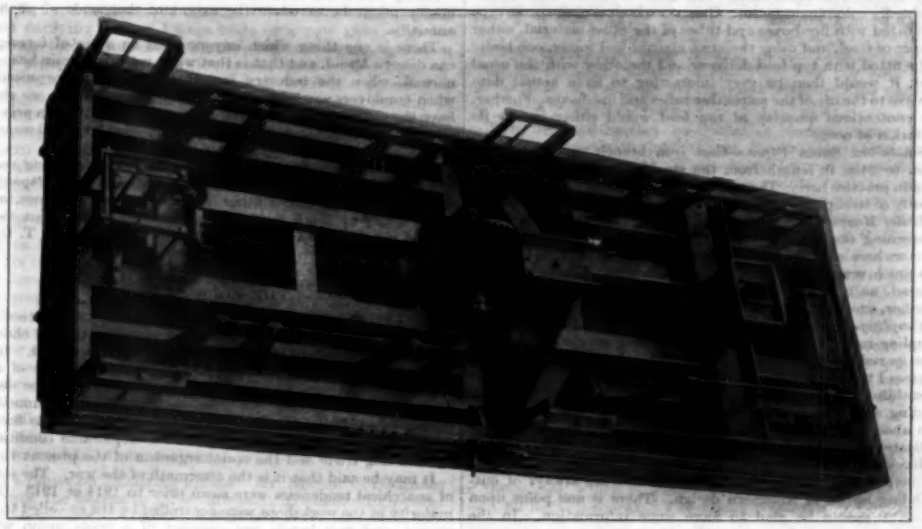
ARRANGEMENT OF POWDERED COAL PUMPING PLANT SECTION THROUGH PULCO PUMP

Ten-Ton Locomotive Steam Breakdown Crane.

The locomotive steam breakdown crane illustrated on page 360 has recently been designed and constructed by the Bedford Engineering Company, of Bedford, to the order of the Metropolitan Carriage, Wagon and Finance Company, Limited, for service on the Great Western of Brazil Railway. It was constructed under the inspection of the company's consulting engineers, Messrs. Livesey, Son and Henderson. The crane is designed to lift loads up to 10 tons at a radius of 20ft., and was tested under steam in all motions with a load of 12½ tons.

The carriage is a riveted steel structure supported upon eight 2ft. 6in. steel-tired wheels set to 1 m. track gauge. Two of the axles are incorporated in a bogie at one end, and one of the remaining two is geared for the locomotive motion. By the operation of a hand wheel this gearing can be entirely disconnected so as to permit the crane to be coupled up to run in a train. All the axle journals measure 5in. by 10in. and run in oil-bath axle-boxes. They are fitted with laminated springs, and the usual packing screws are provided above the springs for levelling the crane when it has to work on a curve. Six draw-out blocking beams, each with a screw jack, are provided to steady the carriage when the crane is at work. The carriage headstocks are fitted with standard central buffer gear, safety chains and rail clips.

The revolving superstructure of the crane includes riveted steel side cheeks extended to the rear and supporting a squat vertical boiler measuring 4ft. in diameter by 7ft. 9in. in height. The boiler is lagged with asbestos mattresses and steel sheeting, and is provided with all the usual fittings, including a pump and an injector. All the steam pipes are of copper. The lattice-braced bent jib measures 25ft. between centres, and the lifting rope is provided with a snatch block having a ball swivel hook and a return hook also with a ball swivel. The grooved hoisting barrel is of wrought steel, and is bolted directly to the hoisting wheel. Upon the full diameter of the latter a brake drum is provided for controlling the load. All gearing throughout the crane is of cast steel, and all the motions are fitted with brakes. The canopy is pivoted at the rear, and can be lifted up in front to give greater head room to the driver when the crane is at work. The normal speeds of working the full load are as follows:—Hoisting, 50ft. per minute; travelling, 300ft. per minute; slewing, 2½ revolutions per minute. The total weight of the crane is 38 tons, and is so distributed that when the jib is lowered and the crane is travelling in train the maximum axle load does not exceed 9½ tons.



UNDERSIDE OF CARRIAGE OF 10-TON LOCOMOTIVE BREAKDOWN CRANE

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH AND AMERICAN LOCOMOTIVES.

SIR,—I have read with much interest Mr. Dewhurst's paper on "British and American Locomotive Design and Practice," and with your permission would like to offer a few observations.

From certain aspects of the paper I am inclined to think that comparisons have been made with much later built American engines and British engines of a rather long-standing design, for which I make due allowance.

Boiler Power.—I hold with the author that the Americans provide a larger proportion of boiler capacity for a given cylinder capacity than the British locomotive builders do. The contract firms at home seem to differ very considerably in assessing boiler power, as the following instance will show. In analysing some designs for a certain type of engine with similar leading characteristics, *i.e.*, boiler pressure, diameter of cylinders and length of stroke, diameter of coupled wheels and axle load, there was a difference of about 550 square feet of total heating surface and 5 square feet of grate area between the highest and lowest assessed engines. The personal equation of the designer will be quite apparent here. When one is in a position to judge comparatively, I am bound to say there is much room for improvement in locomotive design on the score of boiler power.

Horns or Pedestals.—The advantage is with the Americans again in this instance, the width of the bar frame lending itself admirably to the face of the shoe and also being on the centre line of the bearing. The plate frame suffers the disadvantage of having the horn block flanges attached to it, out of centre of the bearing. This, together with other reasons which need not be given here, causes loose bolts and sometimes a crack in the frame over the horn block opening. This is a common trouble, which may possibly be overcome by riveting a stiffening plate—the same thickness as the frame plate—round the opening on the inside of the frames, the horn block flanges being set back to suit. No rivets would be put in the area occupied by the flanges, but the stiffener should be made wide enough to take a row of rivets outside the flanges. In this instance horseshoe horn blocks could be dispensed with and the ordinary parallel pattern used.

Pony Trucks and Radial Axle-boxes.—It is significant that the weight on the American leading pony trucks is much higher per foot diameter of wheel in high-powered engines than anything we have here. If the centrifugal force at peripheral speed is in excessive ratio to the axle load when running fast, the wheels will certainly tend to lift. The addition of extra dead weight in the form of cast iron is sometimes necessary to correct this tendency. The idea, which some home contractors have, of

making the first coupled wheels flangeless after a leading truck is ridiculous. In eight-wheeled coupled engines with leading truck this idea is proposed with the object of reducing the fixed wheel base. It will probably be found that not less than 40 per cent. of the engine total wheel base will be taken up from the centre of the truck to the second coupled wheels—first coupled being flangeless—before these are called upon to do any curving. As the truck will not have more than 10 per cent.—frequently less—of the total weight of the engine on it, the wear and tear of the truck tires can very well be imagined, especially on sinuous curves. As the weight on leading trucks is seldom of a generous margin, they should receive as much help as possible from the leading coupled wheels in curving the engine.

Boilers: Construction and Materials.—The author comments at length upon the different types of boilers and fire-boxes as well as the materials used. The class of water used is undoubtedly a dominant factor. Given two boilers of the same type and fitted with fire-boxes and tubes of the same material, either copper or steel, and using the same class of bad water, one boiler to be fitted with top feed delivery and the other with the usual feed, it would then be very interesting to have actual data relative to the life of the respective tubes and fire-boxes. Further, the contentious question of top feed would either justify its adoption or not.

Smoke-box Steam Pipes.—Cast iron branch pipes of about 18in. to 24in. in length from the steam chest joint have been long in practice here. The upper portion of the steam pipe being mostly of steel pipe, quite good joints being made with lens rings.

Boiler Mountings in Cab.—With regard to the author's remarks concerning the glass gauge cocks, I generally find that contractors here are inclined to place them rather high, thus carrying too much water. This is a serious item when weighing is considered, as is sometimes shown in the case of large engines. Further, excessive surging and foaming is encouraged.

Coupling-rods.—I quite agree with the author that with coupling-rods of excessive stiffness an engine can be running "on its rods." In continental practice for eight-wheeled coupled engines I believe a greater margin is given between the coefficient of stability for the driving and intermediate rods to that for the leading and trailing rods than is given here. The Americans run about the same as we do for stiffness, but, as the author indicates, they gain flexibility by increased diameter and reduced length of joint pins.

Compensating Gear.—These arrangements are always of outstanding notice in American design. There is one point upon which I should be glad to have some information. In the American method of compensating beam arrangement between a pony truck and first pair of coupled wheels the beam and bracket is usually provided with three pin holes, the fulcrum pin shown in the centre hole. I should be much obliged if the author, or any other locomotive engineer who has experience of running American engines, would be good enough to say whether necessity ever arises for the fulcrum pin to be changed over to the hole in front of or behind the centre hole. Apart from the possibility of adjustment, is there any other reason why these extra holes are provided?

General.—There is one other heading which the author might have included in his excellent paper and which would have afforded general interest; that is, the question of maintenance cost of similar engines of British and American design. It would have given us some measure of the relative merits of design, construction and efficiency of service.

Although there are several other points on which I would have liked to touch, I feel that I have already encroached too much on your valuable space. In closing, I will say that there are certain elements of American design which have come to stay, not only in Great Britain, but on the Continent and in the Colonies. Their methods of design and construction are of a varied class and on a progressive scale, ahead of ours. Their mammoth engines bear testimony to exhaustive experiment and research, backed by an enthusiastic interest. Our rigid, conservative policy in years gone by has been largely "to do again what has been done before." It is to be hoped that other colonial engineers will follow the excellent example set by Mr. Dowhurst and produce similar papers in order to promote healthy discussion and impress a live enthusiasm in British locomotive practice.

M.I. Loco. E.

March 27th.

WORKS ORGANISATION AND WAGES.

Sir,—In connection with the present drastic reduction in wages that is being made, may I be allowed to raise one or two points which, I am sure, are being overlooked by employers to-day?

For a considerable time now the cry has been for more and cheaper production, especially the latter. Every man realises the necessity of this, but what attempts have the majority of employers made to effect this end?

Surely the employees' wages should come as a last resource in cheapening production, and if it was being effected as such they would surely take it as inevitable. They know, however, that the contrary is the fact. Wage reduction has come first. If only employers would realise that their own and their shareholders' prosperity depends on their men, and treat them with according fairness.

Why do not directors in this country realise that time is money? If they would but look round their establishments, surely the fact must strike them forcibly that an enormous waste of time is incessantly going on for no earthly reason. It is not the turner, the auto-minder, the miller, &c., who should engage their attention, but the chiefs of their departments. How often does one find petty spite and hostility existing among foremen, resulting in their concentrated efforts to forestall one another at the expense of the firm? Then, in many shops, one can find totally inefficient men at the head of affairs, who have no natural hustle, initiative or administrative powers in their make-up. Often it will be found that a foreman has been "born and bred" in the same works. The management considers that for that very reason he must know more about his job than anyone else. Put that foreman into a fresh works and what becomes of him? On the other hand, one will find an excellent foreman or departmental chief, and invariably he cannot call his soul his own. He must submit everything to higher authority for approval, which authority is often less efficient than himself. Can the time which is wasted as a direct result of the foregoing be calculated? It certainly is enormous annually.

In a large and well-known production establishment I held a post as checker in the works drawing-office composed of eleven designers. One of the best instances of ridiculous waste of time took place here. There was a checker of design and figures, a chief draughtsman, a works drawing-office superintendent, and a works superintendent. Every jig or tool lay-out came from the designer to the checker, from him to chief, on to the works drawing-office superintendent, who consulted the foreman for whose department the design was intended. It would then go to the works superintendent for approval. Can anyone imagine such a preposterous system? What is a chief designer installed for, if he cannot be trusted to send into the works gear for quick and cheap production? It often occurred that a drawing was a week on its travels from designer to tool-room. This is one instance out of countless others where time could be saved by sensible management.

Then there comes a question of timekeeping. One can often see a foreman arriving fifteen minutes late and a batch of operators waiting for him to sign bonus cards or for some other reason. Wasting his own time and that of operators and holding up production. Proceed to the office staff and one will find conditions even worse. Time absolutely thrown away under the very nose of the management.

Surely there are countless other instances where time and money might be saved to the extent of thousands of pounds annually.

There is one thing which anyone with an atom of foresight can discern ahead, and that is that when work has again become normal, when the industry is just recovering its prosperity, when employers are beginning to feel that prosperity, we shall have the old battles fought over again. Strikes will again prevail for increased wages and fair treatment and employers will wonder why.

If only they would set about reducing manufacturing costs by reconstruction of works administration, by cheapening design, and by countless other internal economy schemes, and leave wages at a fair level, surely it would bring about their desired results and save a deal of trouble later on.

T. D.

March 27th.

THE LOCK-OUT.

Sir,—It gave me great pleasure to peruse the letter of "H. G. R.," which is very appropriate at such a time of chaos; but I do not approve of hiding my light under a bushel. It is the duty of everyone who is interested in the welfare of the engineering industry to come forward, for letters in the daily Press have been lacking. It impresses one that the community desires to encourage barbarian methods of a fight to the finish, instead of expressing their views on the deplorable conditions surrounding trade and the social organism of the present time.

It may be said that it is the aftermath of the war. The seeds of anarchical tendencies were sown prior to 1914 or 1913. The majority of the workshops were controlled by the so-called trade unions, and woe betide any member of a trade union who, through misfortune, had been expelled through being in arrears with his contributions; the law was laid down to the administration of the works that unless the unfortunate worker was instantly dismissed the union officials would call out the members of the union, or in other words, "down tools."

I have no desire to see trade unions abolished; they are organisations which are indispensable. They must be more devoted to protecting the interests of those who have been fortunate enough to be kept at the trade for a number of years through their parents desiring to see their sons obtaining their wish of becoming craftsmen.

It is said to be over the question of overtime that the estranged relationship has arisen from. The majority of intelligent persons can see far beyond that scapegoat. It is a case of the theorists trying to prove that the formula which has already been tried and does not coincide with the approved principles which has been in vogue for an indefinite period. We all require to be governed. Employers require to be controlled as well as the workers. There is many an employer who would sacrifice his interests and take on contracts for the sake of his workers, and the majority of workers would only too willingly work overtime for increasing their earnings. It is common knowledge in all workshops that when overtime has to be wrought that the workers vie with each other to be allowed to work, just the same as when a night shift is resorted to, those who are chosen are supposed to be lucky, for their pay will be considerably increased and allows a long week-end.

Look at the question from a common-sense point of view. Would any employer insist on his workers working overtime if it could possibly be done without; would he pay 50 per cent. higher wages unless he was compelled to? I do not know the British workman who would refuse to forgo a few hours of leisure as long as he knew he was receiving a just reward. It is both beneficial to the worker and the employer, for the man on the spot knows what is wanted. It is only through being patriotic and casting all selfish motives into the abyss that we will be able to regain that which has been lost. Employers are often handicapped for want of space. When peace is declared it is to be hoped that the employers will devote more time to human efficiency. Every worker likes to see his employer or managing director occasionally; it fosters an affection which money cannot buy, as the old axiom "Trade follows the flag," and not to be compared with the London omnibus conductor, whose children know him as the "bloke who takes his dinner here on Sundays."

Robert Keddie.

Eltham, March 27th.

SAFETY OF RAILWAY EMPLOYEES AND THE PUBLIC.

Sir,—There will come before the International Railway Association's next meeting a comprehensive report by an expert of world-wide repute, Mr. George Gibbs, on railways operated electrically in America, in which more complete data is brought together than has been collected before. There are, *inter alia*, figures of capacities of installed plants on each railway, in power-houses, and in sub-stations, also train miles, ton miles, peak loads, and average loads; which data have already met with appreciation from practical engineers throughout the world. The report appeared in December, 1921, issue of "Proceedings" of the International Railway Association."

In that report there is a paragraph tactfully putting what, to me, seems to amount to a well-deserved criticism of a decision arrived at in Great Britain: "to allow the installation of a 1500-volt third rail, presumably for special cases only and for operating conditions and clearances pertaining to railways in Great Britain which do not exist in America."

What are these conditions and clearances that render 1500 volts near the ground fit for Great Britain but not fit for America?

Much American rolling stock when new has the centres of axles 16.5in. above rail top. That puts the third or conductor rail 27in. from gauge line horizontally, where in Great Britain we adopt 16in. No other clearances materially affect the problem. Mr. George Gibbs states also:—"It will be difficult to install within American railway clearances a properly insulated and protected 1500-volt third rail; in fact, it is believed impracticable to do so in a manner which will adequately safeguard the public and employees."

In the interest of lives of railway employees and to avoid unnecessary fire risks to employees and passengers and public, let us be safe in our plans and let us avoid so unsafe a standard as 1500 volts in a conductor near the ground.

London, March 24th.

Safety First.

TIMOTHY HACKWORTH AND THE LOCOMOTIVE.

Sir,—Anyone venturing to draw attention to the doings of a forgotten or neglected inventor is at once assailed by the very proper demand for dates and documents. In my remarks on Timothy Hackworth I gave both, and regret the result does not satisfy Mr. Warren. I appreciate his parable. The chemist is indispensable. Only the other day two learned societies were amiably discussing the correlation of the chemist and the engineer. Now comes Mr. Warren and points out the connection between the chemist and the historian. I am ready to go further still and assume the desirability of co-ordination between the chemist and anybody. Thence by induction we arrive at the logical conclusion that biography should be written, not by the historian alone nor by the engineer, but by the chemist, the one individual who can draw a dividing line between fact and inference.

Mr. Warren omits to mention that the locomotive he alludes to as being under negotiation between Robert Stephenson and Co. and the railway committee was a "trial" engine. But it is in regard to the Russian engine he most disappoints me. I gave him just the evidence he asked for—dates and documents—only to find his inquiries are still incomplete and awaiting "information from Russian sources." It is a matter of small public interest whether Hackworth's engine arrived in Russia five minutes before or five minutes after Stephenson's, but in trying to strip Hackworth of any shred of credit for his locomotive achievements Mr. Warren might have left this trifling fragment, at least until he was sure of his ground.

A letter in your issue of last week refers to the use of metallic pistons in early locomotives. Perhaps the two brief extracts given below may not be without interest. The first is from a letter in my possession, written by George Stephenson to Timothy Hackworth, dated May 3rd, 1826, just after the third engine from Newcastle had been sent to the Stockton and Darlington Railway, and asks, "How do the brass pistons answer?" The second is a note from a memorandum book of Hackworth's, where he writes that on May 14th and 15th, 1828, he was at Newcastle, Robert Stephenson and Co., where he gave directions about a locomotive to have "metallic pistons."

March 27th.

Robert Young.

WELSH BOILER TESTS.

Sir,—The very interesting results with South Wales fuel on mechanical stokers at a colliery, published in the current issue, page 340, will be read with varying expressions of opinion by colliery managers and engineers in other parts of the country. The comparison, after all, is not between hand-fired and machine-fired furnaces, but between hand-fired natural draught and machine-fired forced draught.

South Wales semi-bituminous coal is undoubtedly the most suitable fuel in the world for Lancashire type boilers, so far as efficiency is concerned. It is, however, a slow-combustion coal, as is proved in the above tests by the fact that with a draught of .6in. W.G. in the side flues, the rate of combustion was only 22 lb. per square foot of grate per hour and the evaporation 5554 lb. of water per hour on a 30ft. by 9ft. Lancashire boiler. The calorific value of the fuel used is not stated in the article, but calculating this, it would appear to be in the neighbourhood of 11,800 B.Th.U. per lb., which represents a good average fuel.

Combustion technology is an exact science and follows the universal law of causation. Remembering this, it is difficult to reconcile the figures given. All other conditions being similar, the two chief indices of loss are percentage CO_2 and temperature of gases leaving boiler, the latter, unfortunately, not being stated. Taking the results given as follows:—

	CO_2. Per cent.	Rate of evaporation per lb. lb.
Hand fired	11.15	5,554
Mech. fired	12.31	10,390

The natural advantage due to this increased CO_2 per cent., with same flue exit temperature would be exactly 1.6 per cent., and as it is only reasonable to assume that the temperature of the exit gases was higher at the larger rate of evaporation, this would be more than lost, and one wonders how with the same class of fuel the extra 14.27 per cent. increased thermal efficiency claimed was obtained. The only other source of loss, of course, being "ash in clinker"—this item, again, is not given—and if it represented this difference, it would show downright carelessness in cleaning out and poor boiler-house supervision.

V. R. Chadwick.

London, W.C. 1, March 28th.

MANAGERS AND EMPLOYERS.

Sir,—Anyone who happens to be employed by our large limited companies to-day must sadly endorse "Nemo's" remarks in your issue of March 24th, respecting the utter incompetence, blundering and wicked wastefulness of so many of our so-called industrial directors. But how can this be changed? You can hardly expect such men to look into the "mirror of truth" and then correct their own failings. If managers thus placed complain or are bold enough, or, through long experience, qualified enough to point out better or more economical methods, they are immediately "side-tracked" or not wanted, no matter how long or faithful their services may have been. For in these days "there is no sympathy in business"—and why not?

Another fruitful source of injury to managers is the constant or frequent amalgamation or absorption of our business firms, for the staff of the weakest invariably has to make way for that of the strongest.

Then, again, so many directors have sons, cousins, or maybe wife's relations, who know less than themselves or nothing at all about the work to be performed, but, of course, "dear Horace" must have a job near the top of the tree. And so they are pitchforked into managerial positions they are utterly incapable of filling, to the detriment of the company, the spade-workers of years, and indirectly our country, which is now in keen competition with the leading nations of the world.

Surely experience and skill is better than ignorant "new blood," and the cautious, skilful and tactful helmsman than wasteful, advertising "hustlers, who are certain to cause friction between masters and men? Protection for long-service, skilful and willing managers is undoubtedly necessary. But how can that protection be obtained?

March 29th.

Vincere vel Mori.

Railway Matters.

THE Railway Amalgamations Tribunal approved on Monday last the scheme for the amalgamation of the North-Eastern and Hull and Barnsley companies, and it comes into operation to-morrow, April 1st.

THE Bill, jointly promoted by the Port of London Authority and the Midland Railway, for powers to construct a floating landing stage and other works at Tilbury has passed through Committee in the House of Commons.

A FIRE, caused, it is reported, by a spark from a stove, destroyed a workshop of 360ft. long and 100ft. broad at Toulouse, on the 25th inst. The shop was used for the construction of railway material and for stocking timber employed in the making of railway coaches. The damage is estimated at several million francs.

FOLLOWING on Lord Ashfield's statement mentioned in this column of our issue of March 17th, comes one, in answer to a question, by Mr. Hilton Young that the agreement has not been completed. In substance, the agreement is likely to be that the Treasury will guarantee principal and interest of issues of debentures up to £5,000,000. There is no question of a capital advance, as that would be outside the Act.

IN this column of our issue of March 10th, we announced that Mr. C. Cumming, the locomotive, carriage and wagon superintendent of the Highland Railway, had resigned owing to ill-health. We understand that the directors have appointed Mr. D. C. Urie, assistant locomotive engineer of the Midland Great Western, to succeed him. Mr. Urie is the son of Mr. R. W. Urie, the locomotive engineer of the London and South-Western Railway.

ON March 16th, Mr. Marshall Stevens asked the Parliamentary Secretary to the Ministry of Transport whether, as the Railway Rates Tribunal would almost certainly be fully occupied for two years in adjusting the millions of rates and charges, he would see that no other duties beyond those provided for in the Railways Act were undertaken until that most important revision was completed. Mr. Neal promised that the point should be borne in mind.

PUBLIC notices have been given by the railway companies concerned, of meetings of the proprietors in order to approve of the preliminary agreements for the amalgamation of the Barry Railway with the Great Western, and for the latter company to absorb the Elesbury, Mortimer and Ditton Priory Railway, the Penarth Harbour Dock and Railway, the Port Talbot Railway and Dock, the Princetown Railway, and the Rhondda and Swansea Bay Railway companies.

FROM April 1st the wages of railway servants will, owing to the decrease in the cost of living, be reduced by 2s. per week under the sliding scale and by a further 2s. from the extra pay awarded in June, 1920. It is said that each shilling per week saved means one million pounds a year to the companies. These reductions will mean that wages have been reduced 17s. a week since April 1st, 1921. Certain grades are now down to the standard rates agreed to in January, 1920.

WITH the exception of the Caledonian, none of the principal railway companies gave in their 1921 reports particulars as to the receipts and expenditure for the 4½ months since Government control ceased. The net receipts of the Caledonian for this period, when compared with the corresponding weeks of 1920, decreased £241,851. From information given at the annual meetings, it seems that the North-Eastern loss was £849,000, the Midland £413,651, and the Great Central £325,304.

COMPETITION between the east and west coast routes is getting more severe. The North-Eastern runs an express from Leeds to Edinburgh and Glasgow, which leaves York at 9.38 a.m. and is due at the two cities named at 1.45 and 3.10 respectively. The Great Northern from April 3rd will start its 4.55 a.m. from King's Cross ten minutes earlier, and get it into York at 9.18 to connect with the express from Leeds. The relief to the 10 a.m. from King's Cross will be restored. It leaves at 9.50, and does not call in York Station.

THE construction of a railway from Brazzaville to the coast was among the improvements for the execution of which the Government of French Equatorial Africa was some time ago authorised to contract a loan of 171 million francs. Definite plans for this railway for a distance of 300 kiloms. (186½ miles) have already been passed, and a recent decree has authorised the continuation of the surveys; first, for the remainder of the proposed line, i.e., about 250 kiloms., say 155 miles, the cost of which is estimated at 500,000f.; and, secondly, for the selection of a terminus to the north of the Pointe Noire, the cost of which is being placed at 1,500,000f.

THE suggestion has been made that the tenth Congress of the International Railway Association should be held in London in 1925, and form part of the celebrations of the centenary of the opening of the Stockton and Darlington Railway in 1825. We would, however, draw attention to the paragraph on page 186 of our issue of February 17th, which said that, subject to the approval of the general meeting in Rome, the Congress will meet in Madrid in 1927. Meanwhile, the Institute of Transport announces that it will undertake to arrange suitable celebrations of the centenaries of the opening of the Stockton and Darlington Railway and the Rainhill trials of 1829.

ON page 304 of our issue of March 17th we referred to a statement made by the Under-Secretary of War on February 22nd as to 100 locomotives having been built at Woolwich which remain unsold. This matter formed the subject of a White Paper, No. 53, as to a grant for the Government Ordnance Factories, wherein it was said that 100 were ordered for stock, for which no definite purchaser is yet in view; and other work was taken at firm —competitive—prices which were payable on completion and did not cover the full cost shown by the manufacturing accounts. Consequently the value of "alternative" work in hand on March 31st, 1921, had not been recovered at all, and the cost of finished work of the second—firm price—kind was not fully covered by the prices realised. The vote in question, after an explanation by Sir L. Worthington-Evans, was passed on Friday evening last.

Notes and Memoranda.

AN interesting example of timber preservation is the use made of the natural copper sulphate waters, as a preservative agent, at the East Butte mine, Montana. Main cross-cut and drift sets which have been thus treated for a period of two to three weeks were placed in drifts where conditions for decay were unusually favourable. Some of the sets have now been in place for more than ten years, and are still in good state of preservation, while untreated sets in the same workings lasted only two to three years, when they were entirely destroyed by decay and had to be removed.

A FRENCH engineer, M. Eugene Royer, has, it is reported, been carrying out at Lyons tests of a new invention for cutting steel under water. The apparatus is an oxyhydrogen blow-pipe, the flame of which is stated to be just as effective under water as in the air. A diver, it is claimed, can take the blow-pipe under water with him and employ it to cut through the thickest steel plates. After having submerged a piece of armour plating 18 mm. thick in a cistern of water about 3ft. deep, M. Royer, it is reported, was able to cut through the plating, making a cut 17 cm. in length in 65 seconds. Screw shafts 305 mm. in diameter were cut through after the blow-pipe had been applied for five or ten minutes.

THE London Toll exchange has now been in operation for six months. The area covers roughly all places outside the London area within a 25-mile radius of London, and it is proposed to extend the Toll area to roughly double that radius as soon as possible. The average number of calls made weekly through the Toll exchange has been 32,000, 95 per cent. of which have secured immediate connection. The new exchange has also helped to lessen the time required for communication when calls are made much further afield. Of the 12 million trunk calls formerly made annually, 35 per cent. have been for subscribers in the Toll area, and, relieved of these, the trunk exchange has been able to expedite the remaining work, says the *Times*.

IN a paper on "Cutting Fluids," Mr. Eugene C. Bingham explains the necessity for a lubricant in machining operations as follows:—It appears that whenever two clean surfaces of metal are brought together they tend to seize. Many examples prove that a quite invisible layer of impurity will prevent seizure. The clean metal of the chip moving over the face of the tool under great pressure affords a peculiarly difficult problem in lubrication. Lard oil has a much higher adhesion for metal than do the pure mineral oils. It is drawn in between the chip and the tool and forms a strong film which prevents the chip from adhering to the tool and forming a "bead." Other oils containing fatty acids, or groups of atoms with "residual affinities," such as sperm oil, castor oil, rape oil, &c., have in large measure the advantage of lard oil. It seems readily possible to improve mineral oils as cutting fluids and as lubricants by adding liquids of high adhesion such as oleic acid, pine oil and fixed oils.

IN the course of a paper read before the Royal Society of Arts, Dr. Alexander Scott gave the following hints as to the best means of removing all traces of chlorine, or salt, from iron specimens. A certain amount of chlorine may be removed by simple washing, but unless we can convert the chlorine in the usually insoluble oxychlorides into a soluble form such as sodium or ammonium chloride, there is but little prospect of success. The objects should, therefore, be boiled with caustic soda solution or with a solution of sodium carbonate or in many cases sodium sesquicarbonate, followed by copious washing as long as the wash waters indicate the presence of chlorine when tested with silver nitrate and dilute nitric acid. Finally, the last traces of chlorine should be urged to leave the metallic object by the application of a weak electric current, so arranged that the specimen is the negative pole and the positive pole a plate of zinc, copper or silver, and the liquid electrolyte either very dilute sulphuric (or other) acid or a weak solution of soda or other alkali.

IN a paper on "Coal Leading by Road, with Special Reference to Electric Battery Vehicles," read by Mr. I. S. Mackenzie before the North of England Branch of the Association of Mining Electrical Engineers, some operating figures are given for a vehicle having two compartments, each of which holds 15 cwt. of coal. The figures are based on the assumption that the roads over which the lorry has to run are reasonably hard and moderately level and that the average lead from the filling hopper to the point of tipping and back again to the filling hopper is altogether 1 mile, and that the lorry runs 30 miles per day—which is well within its battery capacity on one charge—for 300 days per annum, so that it delivers $2 \times 30 \times 300 = 18{,}000$ loads per annum. The author assumes £1100 as the capital outlay, the standing charges being £570 per annum. Running charges are estimated on the basis of 13,500 units at 1d. per unit and 1.5 units per mile, and costing £56. The cost of tires is given as £22; lubrication, £9.4; repairs and maintenance, £56, making a total annual running charge of £144. The total cost per 15 cwt. load delivered is stated to be 9.5d.

THE question of refuse disposal in Calcutta has been for some time a source of trouble to the Corporation. There is a municipal railway for carrying the refuse out of the town, but some months ago the Corporation began experimenting with motor wagons for refuse removal. According to the *Electrician*, petrol-driven vehicles were introduced at first, but more recently the electrically propelled lorry has been tried. At present there are ten petrol lorries and two electrics in service, each type having the same carrying capacity, viz., 3½ tons. The provision of additional vehicles has recently been under consideration, and in connection with the proposal a report has been submitted in which it is pointed out that, excluding interest and depreciation, the running cost of an electric lorry is only about half that of a petrol lorry. In Bombay, where electric vehicles are employed, there has been very little trouble with batteries. The Calcutta Corporation has therefore decided to obtain tenders for eight more electric lorries, and to make provision for the cost in next year's estimates. By having the same number of each type of vehicle it is hoped to be able to obtain reliable figures of the relative working costs.

Miscellanea.

AN inter-communal syndicate has just been formed at Epinal for the purpose of studying a plan for the linking up of a group of communes in the Vosges department for the purposes of a common scheme of electrical supply.

EXPERIMENTS are being made at Fushun Colliery, Manchuria, in the manufacture of Coalite, a smokeless briquette fuel produced by a dry distillation process from dust, coal and slack. Forty tons are already turned out a day, and it is hoped to increase the quantity very shortly to 240 tons.

THE large dock under construction at Santander will not be finished until next year. Bairds Mining Company is building a new loading berth and deposit for their iron ore in the Astillero River. When completed, the loading of mineral at the rate of 1000 tons per hour will be possible, a quantity which other iron ore tips cannot deal with under ten hours.

THE first all-British co-operative sample room was opened in Brussels on the 28th inst. by Sir George Grahame, the British Ambassador. The principal room, in which the exhibition of samples is housed, is a lofty building more than 50ft. by 40ft., and has a large glass roof giving bright daylight to every corner. There is a secondary or minor hall 40ft. by 25ft. The premises are situated at 9, Rue de Ligne, right in the business centre of Brussels.

THE Hydro-electric Power Commission of Ontario placed in operation on March 15th the second unit of the Queenstown-Chippawa (Niagara) development, having a capacity of 55,000 to 60,000 horse-power. On the same day the Commission arranged for the cancellation of contracts for the supply from another source of 25,000 horse-power, and the new generating unit will at once be placed on half load to meet that demand. The third unit is being installed, and, it is expected, will be in operation in the course of three months.

THE construction of the steamer Bismarck at the Blohm and Voss shipyards has been completed. The cost of the vessel, which is adapted for oil fuel, has, it is said, been 60 million marks. The vessel was expected to leave Hamburg on March 28th, and to commence her trials at Cuxhaven yesterday. As a matter of fact, it is reported that some trouble was experienced during the voyage, and that the vessel grounded. Should the trials, when they are carried out, prove satisfactory, she will then be handed over to the White Star Line, by which she has been renamed the Majestic.

ANOTHER new blast-furnace is being put up in North China to smelt the ores mined at Lung-yen, near Kalgan, which were previously sent all the way to Hanyang for reduction. The new works, which are nearly completed, are in direct communication with Peking by railway. The furnace will be 147ft. in height, and will have an average producing capacity of 250 tons of pig iron every twenty-four hours, with a maximum capacity of 300 tons. The whole equipment includes, besides the furnace, five Wickes vertical tube boilers of 2500 horse-power, three electric generators of 2500 kilowatts, two turbine blowers, four stoves, and a number of pumps. The company will also construct a foundry capable of producing 20 tons of castings a day, a pattern shop, a blacksmiths shop, and a machine shop for repairs.

THE shortage of electrical energy in Italy, caused by the long drought, has brought about a crisis in the paper industry, which has resulted in a 50 per cent. reduction in the output of twenty of the leading paper manufacturers. A further cause of the depression is found in the cheap imports from abroad, especially from Germany, which, owing to its depreciated currency, is able to dump large quantities of paper across the Italian border, where the facilities for manufacturing are less up to date than are those in Germany. The paper market is at present congested with quantities left over from last year's stocks. In normal times stocks amount to some 42,000 quintals, but to-day they amount to over 95,000 quintals. With the return of electrical energy supply and the absorption of the old stocks, the Italian paper manufacturers are looking for a better year's business.

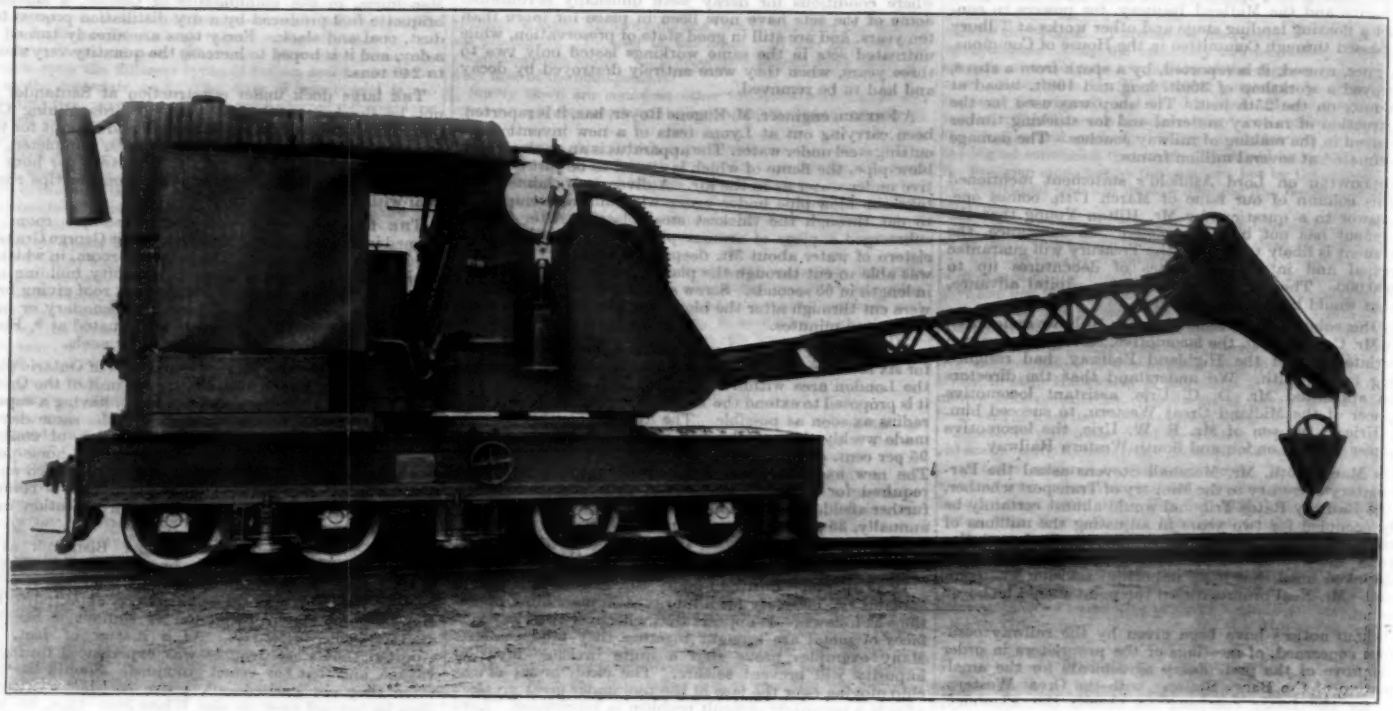
PROPOSALS have been submitted for the construction of a hydro-electric plant to take advantage of the water-power of the Upper Natisone River, between Udine and Julian Venetia. The central station would be situated at Stupizza, which is on the banks of the Natisone, south-west of Caporetto, between there and Cividale, in the Province of Udine. The estimated cost of the necessary works is 20,000,000 lire. It is proposed to supply energy for electric railway lines, public and private lighting and industrial plants, of which a number already exists, the erection of others being contemplated as soon as the electric generating station, which will be the first of its kind in the vicinity, has been completed. In the Provinces of Venetia and Mantua the Government is also proposing to spend 36,000,000 lire upon new hydraulic works, including, among other projects, the Po-Brondolo Canal and the inland waterway between Venice and Milan, *viâ* Brondolo, Cavanella, the Po River, Cremono, and Lodi.

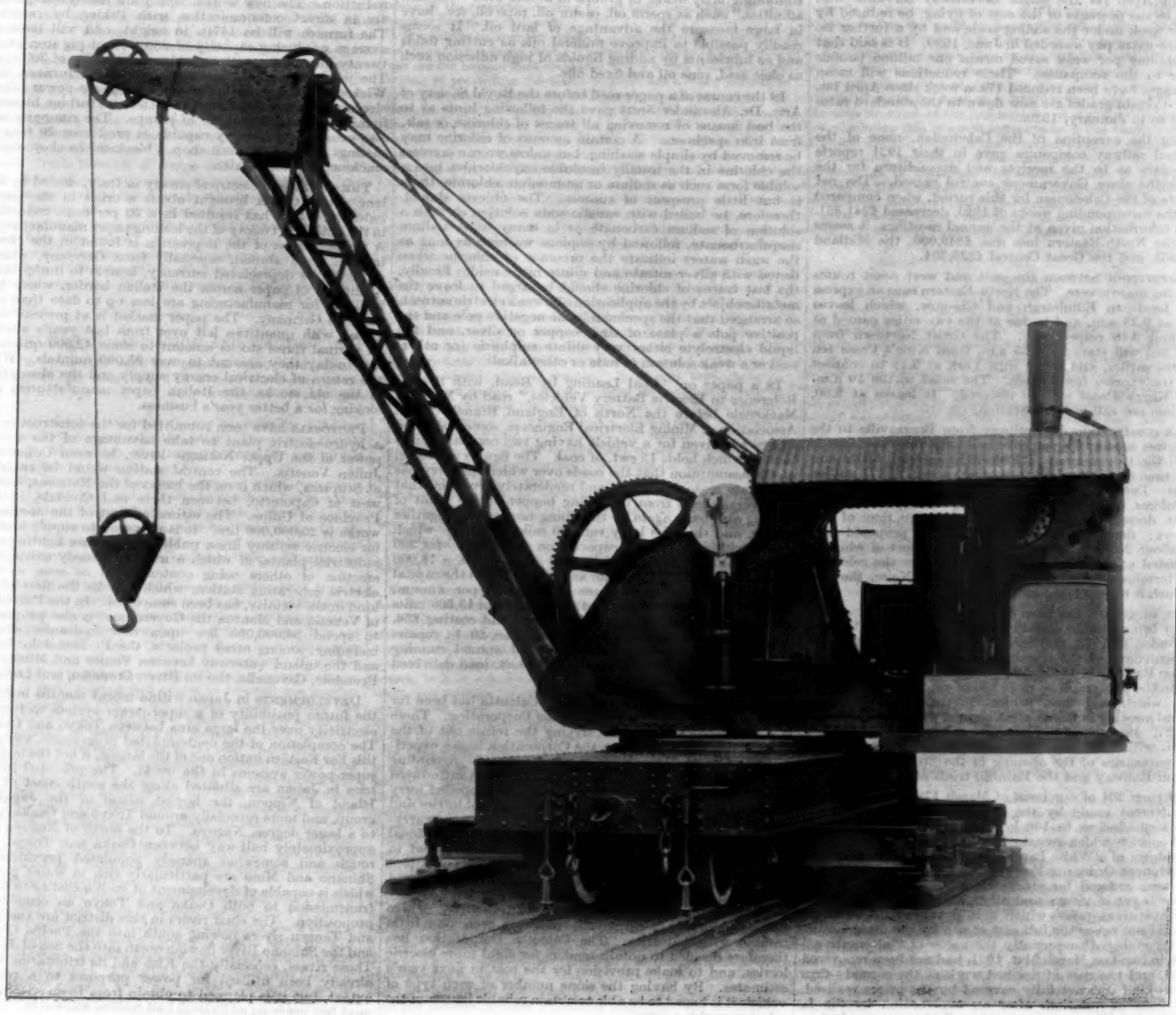
DEVELOPMENTS in Japan within recent months indicate the future possibility of a super-power system to furnish electricity over the large area between Tokyo and Osaka. The completion of the contemplated programme will give this Far Eastern nation one of the largest, if not the largest, super-power systems in the world. The principal industries in Japan are situated along the south coast of the Island of Nippon, the largest island of the Japanese group, and more especially around Tokyo and Osaka, and, to a lesser degree, Nagoya. To the north of Nagoya and approximately half-way between Osaka and Tokyo, the rough and somewhat sparsely populated provinces of Shinano and Mino are particularly rich in water power, which is capable of development at such a cost as to make transmission to both Osaka and Tokyo an economical proposition. The chief rivers in this district are the Kiso and Tenryu rivers flowing south into the Pacific Ocean, and the Shinano River flowing north into the Sea of Japan. These rivers, especially the Kiso and its tributaries, have already been utilised for power purposes to a certain extent, but it is planned to obtain from them within the next few years an additional half-million kilowatts.

10-TON LOCOMOTIVE BREAKDOWN CRANE

THE BEDFORD ENGINEERING COMPANY, BEDFORD, ENGINEERS

(*For description see page 387*)





AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris. CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND CO., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.
ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto I, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.
JAPAN.—MARUZEN CO., Tokyo and Yokohama.
AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND CO., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND CO., Gresham-street, Adelaide.
CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS CO., 386-388, St. James-street, Montreal.
TORONTO NEWS CO., 42, Yonge-street, Toronto.
CEYLON.—WIJAYARTNA AND CO., Colombo.
JAMAICA.—EDUCATIONAL SUPPLY CO., Kingston.
NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND CO., Auckland; J. WILSON CRAIG AND CO., Napier.
STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS CO., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—BRITISH AND COLONIAL PRESS, Inc., 736, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—AGENCE VOX, 7, Rue de Surène, Paris (VIIIe).
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SOUTH AMERICAN BRANCH OFFICE OF

The Engineer.

526, Bolsa de Comercio, Buenos Aires.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.
Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.
If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly	£1 11s. 6d.	Half-yearly	£1 13s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum.
Thick paper edition .. .. £3 3s. 0d. ,,

ADVERTISEMENTS.

. The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication) ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of THE ENGINEER.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

. *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

. *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

. *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, March 31st, 1922.

	PAGE
DEVELOPMENTS IN POWER STATION DESIGN. No. XXVI. (Illus.)	347
THE FUTURE OF THE BRITISH LOCOMOTIVE TRADE	350
THE INSTITUTE OF METALS. No. IV.	351
WORM REDUCTION AND CHANGE-SPEED GEARING. (Illus.)	352
ALL-ELECTRIC AUTOMATIC POWER SIGNALLING ON THE METROPOLITAN RAILWAY	354
INDIAN ENGINEERING NOTES	354
TELEPHONIC COMMUNICATION WITH NORTHERN IRELAND	354
A SEVEN-DAY JOURNAL	355
INSTITUTION OF MECHANICAL ENGINEERS	356
A PUMP FOR POWDERED COAL. (Illus.)	357
TEN-TON LOCOMOTIVE STEAM BREAKDOWN CRANE. (Illus.)	357
LETTERS TO THE EDITOR—	
British and American Locomotives	357
Works Organisation and Wages	358
The Lock-out	358
Safety of Railway Employees and of the Public	358
Timothy Hackworth and the Locomotive	358
Welsh Boiler Tests	358
Managers and Employers	358
RAILWAY MATTERS—NOTES AND MEMORANDA—MISCELLANEA	359
LEADING ARTICLES—	
Aviation and National Defence	361
The Steam Locomotive	362
THE INTERNATIONAL RAILWAY ASSOCIATION. No. I.	362
REINFORCED CONCRETE GAS PRODUCER. (Illus.)	364
PORT DEVELOPMENT IN CHILE	364
AN IMPROVED FOUNDRY MELTING PLANT. (Illus.)	365
IMPROVED EXHAUST STEAM INJECTOR. (Illus.)	366
PEAT EXPLOITATION IN ITALY	366
INSTITUTION OF ENGINEERS, INDIA	366
THE NEWCOMEN SOCIETY	367
SAFETY PRACTICE FOR MINE HOISTING ROPES	368
LAUNCHES AND TRIAL TRIPS	368
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	368
Lancashire	369
Sheffield	369
North of England	370
Scotland	370
Wales and Adjoining Counties	371
PERSONAL AND BUSINESS ANNOUNCEMENTS	371
EDUCATIONAL INTELLIGENCE	371
CURRENT PRICES FOR METALS AND FUELS	372
FRENCH ENGINEERING NOTES	373
BRITISH PATENT SPECIFICATIONS. (Illus.)	373
FORTHCOMING ENGAGEMENTS	374

THE ENGINEER.

MARCH 31, 1922.

Aviation and National Defence.

HAD anyone foretold at the date of the Armistice that in less than three and a-half years after that event the problem of national defence would again have become urgent, the prediction would almost certainly have been received with derision. At that time the country, exhausted by a protracted struggle which had strained its resources almost to breaking point, looked forward to a long period of peace and consequent relief from the burden of armaments. It soon became evident, however, that this expectation would not be fulfilled, that the successful issue of the war had left us with heavy commitments which necessitated the upkeep of strong naval and military forces, the cost of which, owing to the reduced purchasing power of money, would be disproportionately high. And now, at this moment of acute financial stringency, when political economists unite in advocating drastic retrenchment as the only means of saving the State from fiscal shipwreck, the public is confronted with the disconcerting, but indisputable fact that the armaments we are maintaining at such formidable cost no longer constitute a line of defence behind which Britons may sleep quietly in their beds. It is not an exaggeration to affirm that air power has revolutionised the principles upon which for centuries past our system of national defence has been based. Before the advent of this new factor, our strategical requirements could be simply stated. Since, as long as we exercised command of the sea, we could neither be invaded nor starved, a supreme Navy was the first essential, and such a Navy we always contrived to maintain, though at times by a dangerously narrow margin. The size of the Army was governed more by considerations of Imperial strategy than home defence, and it was a tribute to the soundness of the national instinct that the claims of the Navy, except in a few isolated instances, were always accorded priority, notwithstanding the efforts made from time to time by military partisans to invert this order of precedence. But the day is rapidly approaching—if, indeed, it has not already arrived—when the whole question of defence will have to be reconsidered *de novo*, for, in the deliberate judgment of many distinguished strategists, the Navy has ceased to be our first line of defence, and is no longer competent to fulfil its elementary function of guarding the home territory from invasion. This thesis has been expounded with admirable clearness by Brigadier-General Groves in the articles he has lately contributed to *The Times*. Briefly summarised, his argument is that the development of aviation has changed the character of war, making it henceforth primarily an affair of areas instead of "fronts"; that the next great international conflict will be inaugurated by bombing attacks of such magnitude as to make the heaviest raids experienced a few years ago mere child's play. Raiding aircraft will no longer operate in squadrons but in whole fleets, and owing to the increased range, carrying capacity, speed and general efficiency of the individual machine, these air offensives will be incomparably more effective and devastating than any similar operations conducted during the late war. "Each side will at once strike at the heart and nerve centres of its opponent: at his dockyards, arsenals, munition factories, mobilisation centres, and at those nerve ganglia of national *moral*—the great cities. The air raids of the past are no guide as to the nature of future aerial attack, or even of that which could be delivered to-day."

To those who are familiar with aircraft and engine development since the war, the truth of General Groves' forecast, so far as it concerns the material element, is self-evident. Moreover, this progress continues, and the most experienced aeronautical engineer would hesitate to set any bounds to the evolution of the aeroplane. There has been a corresponding and perhaps even more sensational improvement in the chief weapon of aerial warfare, namely, the bomb. In a recent issue of this journal we described and illustrated a bomb weighing two tons, which has been manufactured in the United States, and there would be no difficulty whatever in producing explosive missiles of much greater weight and destructive power, progress in this respect being limited only by the load capacity of aircraft. It has been conclusively proved by actual experiment that aircraft armed with the heaviest type of bomb can destroy the largest battleship, and, although this method of attack is still perhaps only in the earliest stage of development, its possibilities are so clearly recognised that they have already begun to influence professional opinion with respect to the future value of the capital ship, many naval officers holding that air attack is a menace more to be feared than the submarine. But the effect that aviation is likely to have on the strategy and tactics of conventional warfare afloat and ashore is a matter of subsidiary importance compared with the question which has been raised by Brigadier-General Groves. We must ask ourselves what steps can be taken to create an effective system of defence against aerial invasion, which the combined efforts of Navy and Army would be powerless to avert, and the consequences of which, both moral and material, might be even more disastrous than those of actual invasion by a hostile army. This particular danger differs from all the other perils with which the country has been faced in the past, in that it cannot be parried by purely defensive measures. If a neighbouring Power began to expand its navy on a scale that seemed to us inconsistent with amicable intentions towards this country, we could and did meet the implied threat by outbuilding our rival, a process that was always effective, though somewhat expensive. But a threat from the air would, in the nature of things, be infinitely harder to cope with, either before or after it had materialised. Should we, for instance, be justified in taking alarm if we saw a neighbouring State building up an immense mercantile air fleet, and devoting itself with great energy to the development of civil aviation within its borders, whilst at the same time maintaining only a small air force expressly for military purposes? Considering the many points of resemblance between commercial and military aircraft, and the ease with which the former can be converted into the latter, such activity would unquestionably afford grounds for grave suspicion. Yet, unless our own mercantile air service was equally well developed, the only way to meet the situation would be to build a very large fleet of military machines and train the requisite number of pilots, an expedient which any Government would hesitate to adopt, both for political and financial reasons. Nevertheless, it is to be feared that equality in air-power *vis-à-vis*, any State with whom our political relations are likely to be disturbed is the minimum standard that can be accepted if we desire immunity from the terrors of aerial invasion.

To put the matter quite bluntly, the threat of reprisals in kind seems to be the only effective deterrent to aerial aggression. It seems inevitable that, in the warfare of the future, belligerents will resort more and more to *lex talionis*, not out of mere savagery but simply in self-defence. Hitherto, a nation that cherished aggressive designs against a rival of inferior military resources rarely hesitated to resort to arms, knowing as it did that by swiftly

advancing into the enemy's territory and waging the campaign there, its own soil would remain inviolate. That, as we know, was the motive that induced Germany in 1914 to hurl her armies far into France at the first onslaught, with the result that while many smiling provinces of our ally were devastated during the long struggle that ensued, the cities and the countryside of Germany remained practically unscathed. In future, however, any Power that enters into war will do so in the knowledge that it is exposing its civilian population and property to extreme danger, and there is some comfort in the reflection that consciousness of this fact may serve as a check to martial ambition. Meanwhile, the problem of making ourselves reasonably safe against air attack—or the political intimidation to which we might be subjected if our defences were inadequate—must be resolutely faced. There are some who hold that only through the development of commercial flying can we acquire that knowledge and those machines and men which are needed to ensure our safety. There are others who take the view that military aeronautics must be developed just as naval architecture was, and that the fighting and mercantile branches will tend to diverge more and more as the years pass. In one or other of these ways we have to meet a new arm whose potentialities are as yet only dimly seen. It behoves us to settle, and to settle quickly, which course we will take.

The Steam Locomotive.

THE fact that the discussion on Mr. P. C. Dewhurst's paper at the Institution of Mechanical Engineers filled two evenings, and could certainly have occupied a third and fourth, shows that the interest taken in the steam locomotive is still as great as at any time during the last hundred years. It is not wonderful that it should be so, for of all the machines made by the hands of man there is none that presents so many problems as the locomotive and at the same time makes so great an appeal to the imagination. Mr. Dewhurst, basing his opinions on the experiences acquired on the railways of Jamaica, contrasted, detail by detail, American and British designs, pointing out the merits and demerits of each. Whilst it may be admitted that comparisons of the kind can only be perfectly just under conditions which it is wellnigh impossible to ensure, yet the fact remains that by throwing diverse practices into contrast with each other, knowledge is advanced and national bias is weakened. It may be hoped, therefore, that the plan will be pushed further, and that not only will the national characteristics of other locomotives be compared, but that such fruitful fields as are presented by other classes of machinery may be explored with the same care.

It has frequently been said, but cannot be too often repeated, that the locomotive and the road —in which, in a broad sense, we may include all the traffic conditions—must not be considered separately. It is because this elemental truth is forgotten that we so frequently hear derogatory comparisons drawn between American and British locomotives by those who have visited the United States and Canada, and witnessed the performances of the colossal engines used in those countries. Were the critics aware of the limiting conditions in the respective lands, they would undoubtedly find that the American locomotive is as little suitable for Great Britain as the British locomotive is for America. Every machine acquires national characteristics from its surroundings. It is trammelled by a thousand invisible conditions, and is as much the creature of its environment as any living organism. Indeed, it is only by conforming to its environment that it exists at all. If it fails to do so, as many a machine has done, then it disappears, and the inventor rails against fate or the blindness of Capital when he should be reviling his own failure to obey the inexorable law of the environment. It is an easy thing, for example, to say that since the steel box is a success in America, we are mistaken in our adherence to the copper box. The obvious retort, with equal justice, is that since the copper box is a success here, the Americans are wrong to use steel. But neither statement is wholly correct. The fact is that the copper box satisfies all the conditions of workmanship, trade and locomotive operation in this country, and the steel box suits the corresponding conditions in America. The relative merits of the two on statistical grounds are of little importance. Both serve their turn, and there is little to choose between them when all the conditions are considered. Of the bar frame, the same observation may be made. Were it intrinsically better than the plate frame, then the latter would by this time be unknown; or, were the plate frame incontestably better than the bar frame, then the Americans would long ago have adopted British practice. Neither is better nor worse than the other for the conditions under which it is to be used. So it is with nearly all details that persist in a particular form. If they were not satisfactory they would not persist; if any, originating in one country, are taken up by another country, it is because, despite their nationality, they happen to suit the foreign conditions. The critics who forget these facts forget also that British locomotive progress has been at least as great as American progress. In the matter of weight, for example, they have both increased about twenty-five per cent. in fifteen or sixteen years. In the matter of economy, British locomotives are still as much ahead of American locomotives as they are in workmanship and elegance of design. In one respect, America has advanced more rapidly than British, and it would be extremely interesting to examine the reasons in detail. Here we are still tied to an axle load of not more than twenty tons and rails of one hundred pounds per yard are rarely exceeded. In the United States axle loads of thirty long tons are permitted, and on the Pennsylvania Railroad there is one engine at least which scales thirty-three and a-half long tons per axle. Even in America these enormous weights can only be used on certain sections, and are only required for special purposes. They do not represent average or general practice, any more than Churchward's Great Bear or Fowler's Decapod represent the general practice of this country. An interesting point is brought out by the small use of tank engines in America. In this country they do much valuable service, both in train haulage and in shunting. In the United States they are not used, according to Mr. Sanderson, because the water capacity is too low for the long hauls or heavy shunting that has to be done. A more serious objection is the reduction of adhesive weight, which in Billinton's Charles C. Macrae, for instance, may amount to something like fifteen per cent. of the load on the driving wheels as the coal and water are consumed. But this characteristic does not prevent them being extremely useful engines for the particular class of work they are called upon to do, and with all deference to American experience, we do not even now see why tank engines of suitable proportions should not serve American needs in many cases.

Apart altogether from the interest that attaches to the contrasting of national methods of locomotive design, Mr. Dewhurst's paper serves the admirable purpose of focussing attention on the steam locomotive, which progressives appear to regard as an antiquated and stationary invention that must go down soon before the electric locomotive. That end is as yet far from being in sight, and there is still a deal of life in the hundred-year-old machine. Sir Henry Fowler's rather cryptical allusion in the discussion to compounded superheater engines may indicate the direction in which he proposes to move. He has fitted superheaters to several of Dean's compounds, and may find the results so satisfactory that he proposes to build afresh on those lines. Mr. Gresley is pursuing his splendid achievements with three-cylinder engines, and his latest and largest product will before long be on the road. In less conventional directions we have such engines as the Ramsay condensing locomotive, illustrated in our last issue, and other engines with turbo-electric mechanism and condensers are being tried in Sweden and Switzerland. Such signs as these show that the steam locomotive has not yet lived its day, and that at home and abroad it continues to progress. In this country we may make the proud boast that in the workshops of both railway companies and manufacturers the standard of workmanship attained in the making of locomotives is equalled by few and unexcelled by any other branch of mechanical engineering.

BOOKS RECEIVED.

A Treatise on Electro-chemistry. Edited by the late Bertram Blount, F.I.C. *The Electro-metallurgy of Steel*. By C. C. Gow. With a preface by Donald F. Campbell. London: Constable and Co., Limited, 10–12, Orange-street, Leicester-square, W.C. 2. Price 27s. 6d. net.

The Fire Resistance of Concrete and Reinforced Concrete. A synopsis of the tests conducted by the special Commission formed by the British Fire Prevention Committee, and carried out at the Committee's testing station from October, 1917, to September, 1919. Compiled by D. W. Wood, M.B.E. London: The British Fire Prevention Committee, 8, Waterloo-place, Pall Mall, S.W. 1. Price 5s. net.

The International Railway Association.

No. I.

WHEN the International Railway Congress met in Berne in 1910 it was decided, on the invitation of the then German Government, to meet in Berlin in 1915. The Great War rendered a meeting in that year impossible, and not until after the Armistice could any arrangements as to another Congress be made. Owing to the international situation caused by the war the Association of the Railway Congress came to an end, and a new body, known as the International Railway Association, has been created. In February, 1920, it was announced that the ninth Congress would be held in Rome during 1921, but that date was subsequently changed, and the meeting will now be held between Tuesday, April 18th, and Wednesday, May 3rd, of the present year.

As on previous occasions, the Congress will be divided into five sections, which will discuss fifty-five reports on twenty-one subjects. Most of these reports have been published in the monthly bulletins of the Association, and we print in this issue a summary of some of the English and American reports of interest to engineers.

CONSTRUCTION OF THE ROAD BED AND OF THE TRACK.

The above heading is that of Subject I. The matter for debate is "Arrangements to be adopted in constructing the road bed and the track in view of the increase in the weight of locomotives and the speed of trains." Four reports are presented. Mr. F. C. Trench, Engineer-in-Chief, London and North-Western Railway, is the reporter for Great Britain, India, South Africa, Australia, and New Zealand.

Mr. Trench opens his report (Bulletin for August, 1921) by a reference to speed, and says that on the principal railways in Great Britain and Ireland the heaviest passenger trains now weigh from 400 to 500 tons, whilst goods trains weigh 1000 tons and even in some cases as much as 1500 tons. As might be expected, the weight of the engines required to haul these great loads at express speed is now much greater than was necessary even seventeen years ago —the Washington Congress of 1905 considered this question—and although 20 tons still remains the limit of load on an axle, the total weight of the engine has increased considerably. This increase may be set down at about 25 per cent., for, whilst in 1904 the usual weight of an engine and tender was between 80 and 100 tons, the weight is now commonly from 110 to 125 tons.

Road Bed.—When dealing with the road bed illustrations are given of the standards in use on embankments and in cuttings on the London and North-Western, North-Eastern, Great Northern (Ireland), East Indian, and Union of South African Railways. In the general construction below the ballast but little change has been made. More care is, however, now devoted to the proper drainage of the road bed, and with this object the formation is usually cambered 6in. or is given an inclination from the centre to the sides. This inclination varies from 1 in 30 to 1 in 60. In cuttings it was formerly the practice to provide an open waterway at each side of the line, but these drains have to a great extent been superseded by earthenware pipes laid below formation level at the toe of the slope.

None of the changes and improvements made in the track are of a drastic or revolutionary character. In each country the types of permanent way differ to some extent, and it is not always easy to account for these differences, as the conditions often seem to be similar, but in many instances it is noteworthy that the type first adopted is retained and becomes the standard.

Chairs.—The chaired road is a case in point. English engineers are convinced that this type is superior to any other, and it will probably be admitted that the results obtained in smoothness of running, economy in maintenance, and in length of life of the line are at least as good as can be obtained with any other type. It seems, however, possible to account for this essential difference in practice by the theories of evolution. In new countries where timber is plentiful and speed of construction a first consideration it is natural to adopt the type of permanent way that lends itself best to these conditions. Examples are given, with interesting illustrations, of the earliest rails and chairs, and it is there seen that the development of the chaired road has been a process of steady evolution from the earliest days of railways, and that the adoption of a chair was not in any way consequent upon the use of a double-headed rail, but was of much earlier origin. In these days frequent traffic, ever-rising wages, and increasing cost of sleepers, make it desirable that the line, once laid, should be disturbed as seldom as possible. This object can best be obtained by the adoption of a type in which the rails, sleepers and fastenings have all an approximately equal life. Conditions vary so much that this ideal cannot in all cases be attained, but taking the average of main lines in England it will be seen that the chaired road approaches it very closely. For example, on the London and North-Western Railway the creosoted sleepers have a life of about twenty years

in the main line, and the modern fastenings, consisting of galvanised screw spikes, endure in good order for the whole of that period.

It may be argued that relaying and re-sleepering can be carried out more promptly, more economically, and with less disturbance of traffic where the flat-footed rail is employed, but it is questionable whether that is really the case. On some English railways most of the relaying and re-sleepering is carried out on weekdays and without any disorganisation of traffic. The new sleepers are delivered on the line with the chairs already attached to the proper gauge, and whenever a sufficient interval occurs between trains a few lengths of old rails and sleepers are removed and new ones substituted. Where necessary the relaying gang is in telephonic communication with the nearest signal-box. In this manner it is often possible to relay lengths of 400 yards or more of railway in an ordinary working day, even when trains are passing at frequent intervals, and lengths of over 800 yards are sometimes accomplished.

That the chaired road is suitable for present-day speeds and weights seems clear from the fact that the only radical alterations found necessary in recent years are the placing of the sleepers a little closer together and the substitution of screw or bolt fastenings for the spikes and trenails formerly used. With the flat-footed rail, on the other hand, these improvements have been made, and, in addition, sole plates have had to be introduced in many instances to increase the holding power of the fastenings and reduce the abrasion of the sleepers; or, alternatively, steel sleepers have been adopted, which, although more costly than timber and less easy to maintain in proper order, admit of very secure attachment of the flat-footed rail.

The chaired road has been developed for the soft wood sleeper, and the opinion is strongly held that with this class of sleeper no other type of road will so satisfactorily accommodate itself to ever-increasing loads and speeds. Where, however, hard wood sleepers of uniform quality are available in sufficient numbers the superiority of the chaired road is less marked, and it may well be that with these sleepers the flat-footed road will have as long a life.

Ballast.—The laying of the ballast is often done by means of hopper wagons and the spreading by a plough attached to the ballast train. These methods are by no means universal, but they are favourably spoken of by engineers who use them, especially when there is a large amount of ballasting or re-ballasting to be done. The use of mechanical tampers for packing sleepers makes very little progress, and it is doubtful whether these tools can be justified either on the score of efficiency or economy.

Sleepers.—The sleepers for standard-gauge roads in Great Britain were, before the war, 10ft. by 10in. by 5in. Owing to the recent shortage of timber supplies many sleepers 8ft. 6in. long have been used, and as no serious disadvantage has, so far, been found to arise, it seems not unlikely that this length will in future be looked upon as the standard.

In this country there is no marked increase in the use of steel sleepers. Some have been in use for a number of years, and, more recently, some have been laid down experimentally, but developments in this direction have been checked by the prevailing high cost of steel.

Rails.—Great Britain has not, in recent years, increased the weight of rails owing to increased speeds and loads. This is not altogether surprising, for experience seems to show that for loads now existing there is nothing to be gained by increasing the weight of the rails beyond 95 lb. or 100 lb. per yard. The length of rail now most commonly used is 45ft.; the 30ft. rail is seldom laid in England. The extra wear and tear of modern traffic has led to many experiments with rails of harder steel than that demanded by the British Standard Specification, and it seems not improbable that harder rails will be commonly used in the future. The Great Indian Peninsula has, owing to higher loads and speeds, adopted a 100 lb. rail.

Fastenings.—The trenail is gradually falling into disuse and the screw fastening is gaining ground. The Great Northern and two of the Irish railways have adopted a through bolt, first introduced on the Great Western. The coach screw has been used for many years on the London and North-Western. Formerly two screws and two spikes were inserted in each chair, but the use of spikes has now been abandoned and the chairs are secured by three galvanised screws. The latter have a long life and have been found to give very satisfactory service by holding the chair securely during the whole life of the sleeper. The Midland, Great Central, and Metropolitan are other railways using coach screws, usually in combination with spikes.

For the flat-footed road in India and the Colonies dog spikes are the usual fastening, but it is generally admitted that they are far from perfect and need frequent attention with heavy traffic. Coach screws are used on some lines, and whilst some administrations find them satisfactory, others have not had a similar experience and have reverted to dog spikes.

After offering a suggestion as to why the coach screw, which is undoubtedly efficient for securing chairs to sleepers, should prove itself less effective for attaching the flat-footed rail, the report proceeds to the subject of keys, and says that steel keys have been tried experimentally in many places, and whilst some companies report favourably as regards their life and efficiency in decreasing creep, other companies have not found them as effective as teak keys.

Fish-plates are usually supplied coated with oil, and many companies now find it advantageous to remove the plates periodically—say, once a year or once in two years—and re-coat them and the bolts with oil, grease, or tar.

American Practice.—Mr. C. H. Ewing, of the Philadelphia and Reading Railway, is the reporter for America. His report was reproduced in the July, 1921, Bulletin and opens by observing that in the last twenty years there has been an increase in the United States of 25 per cent. in axle loads on locomotives and a corresponding increase in axle loads on cars. The average axle load for locomotives to-day is 66,000 lb. (29.5 long tons), the actual maximum being 75,600 lb. (33.3 tons). These increases have resulted from (*a*) the desire for increased operating efficiency in hauling larger train loads, and (*b*) the introduction of heavy all-steel passenger cars in place of those of wood construction.

The average width of road bed is 33ft. for double track and 63ft. for four-track systems, with additional width as required for side ditches. The widths have increased on account of the necessity for providing increased clearances between tracks owing to the introduction of larger rolling equipment.

Rails.—At the present time a number of roads are using sections of rail 130 lb. per yard or slightly heavier; many others are using sections ranging between 100 lb. and 130 lb. per yard. One of the largest roads which has used 130 lb. section for five years, reports that it is absolutely necessary to use such a section on account of heavy traffic, and notes the following advantages:—(1) Comparatively few broken rails; (2) life of the rail on curves of 6 deg. or over is about two and a-half times the life of 100 lb. rail; (3) the company is able to increase the carbon content from an average of about 0.69 for 100 lb. rail to 0.78 for 130 lb. rail; (4) the track stands up better under heavy traffic.

Sleepers.—Treated sleepers are used extensively. Those treated with zinc chloride and creosote have fully demonstrated that the life is considerably prolonged. Steel, reinforced concrete, and composite sleepers have been used experimentally, but have not come into general use in America.

Appendices give very full details of the practices of seventeen of the principal systems.

M. K. Ahlberg, of the Swedish State Railways, reports for Denmark, Sweden and Norway, and MM. Henry, of the Eastern of France, and Paris, of the Northern of France, for the other countries not otherwise covered.

MAINTENANCE AND SUPERVISION OF TRACK.

Mr. D. C. Rattray, the late chief civil engineer of the then Lancashire and Yorkshire Railway, would have been the reporter for Great Britain on this subject had the Berlin meeting been held. The duty has now devolved on Mr. C. J. Brown, chief civil engineer of the Great Northern, whose report was reproduced in the Bulletin for June, 1921. The problem for discussion is "Measures to be taken to provide an economic organisation for the maintenance and the supervision of the track, taking into consideration the increase of traffic and speed, as well as the rise in wages and in the cost of materials. Use of mechanical appliances. Results obtained."

Gangs for Renewals.—The report observes that the renewal of the track is dealt with in almost every case on British railways by special gangs of men organised for the purpose. The more universal practice is to employ a permanent nucleus gang, which is added to as found necessary by taking on temporary men. The Lancashire and Yorkshire has abandoned its practice of employing contractors for relaying.

Increased Cost of Maintenance.—With practically no exceptions there had been, up to 1914, no variation, as compared with 1900, in the number of men per mile of running line employed in the maintenance of the track owing to increase of traffic or greater speeds; this result being, no doubt, due to its greater strength. Advances of wages of varying amounts were, however, granted fairly generally during that period and caused the annual cost per mile of track maintained, in respect of that item, to go up to an extent varying from 6 to 30 per cent. on British railways and from about 6 to 40 per cent. on Indian railways. During the same period the percentage advances in the cost of material were from 6 to over 50 per cent. on British railways and from 8 to 100 per cent. on Indian railways.

On many of the railways, including Indian and Australian, the strength of the gangs has remained the same, but an increased number of British lines report that additional staff has been put on for ordinary maintenance purposes, owing largely, no doubt, to the shortening of the working hours to an average of 48 per week, the percentage in these cases ranging from a small fraction of 1 up to 13. Partly to compensate for the shortening of the working day, several of the larger British companies have reduced the number of daily inspections of the track from two to one, with no deleterious results so far, and there would appear to be no reason why this practice should not be generally adopted.

The cost of labour for relaying a mile of railway in 1914 varied for the British railways replying to the *questionnaire* from £160 to £470, representing a percentage of increased cost, as compared with 1900, ranging from 7 to 30. By 1920 the cost per mile had gone up to an amount varying from £405 to £1200, the percentage of increased cost, as compared with 1900, ranging between 180 and 387.

Inquiries show that in most cases the companies do not as yet contemplate the taking of any definite action to counteract to some extent the effect of these increases. Several companies are trying or have adopted rails made of special steel, such as sorbitic, high silicon and manganese, in places where wear is exceptional in order to save labour by reducing the frequency of renewals as well as to get a better wearing material.

Possible Economies.—One British company—the answers to the *questionnaire* are not reproduced, so we cannot say which—claims to have effected economies in working through adopting statistical methods of observation, thereby making better use of the men's time and reducing costs. Another company decentralises its staff in order to reduce travelling time. The provision of sleeping accommodation for the men, either in the form of vans or huts, especially on railways passing through the more sparsely populated districts, is being adopted in several cases for the same purpose.

On several of the British railways, when relaying is proceeding on a line on which traffic has not been stopped, temporary telephones, by means of which the man in charge of the work can keep in touch with the signalman in the nearest signal-box, are installed and have proved very beneficial in expediting the work. The extension of the use of telephones in such circumstances is to be recommended, as not only is the progress of the work expedited by reducing to a minimum the length of time the work is stopped to allow traffic to pass, but by such saving of time it may be possible to carry out work during the week which would otherwise have to be done on a Sunday at considerably increased cost.

Chairing the sleepers at the depôt by power enables this work to be done with only a few men and in a more efficient manner than can be done by hand, though the saving thereby effected is counteracted to a considerable extent by the cost of running the chairing plant and the increased cost of haulage owing to the wagons not being able to accommodate anything like the same number of chaired as they can of unchaired sleepers. The advantages, however, of having this work done by mechanical means more than outweigh any objections which may be raised on that score.

Devices are also adopted to save flagmen in certain cases by warning boards and speed restriction signs. On single lines the "key occupation" system saves a flagman in each direction. The use of mechanical tampers is, as Mr. Trench reported, not particularly promising, but Mr. Brown considers that there may be scope for such machines where the system of renewing the track in long lengths at a stretch is adopted.

Ballasting.—With a view to saving labour in the unloading of ballast on the line and reducing to a minimum the occupancy of the track whilst this operation is being carried out fourteen of the British companies which replied to the *questionnaire* use hopper-bottom wagons of various capacities, ranging from 5 cubic yards or, say, 6 tons to 25 tons. If a steady supply of ballast can be ensured so that the wagons can be kept fully occupied an extension of their use is to be recommended, though so far at least two of the largest of the English railways—again no identification is available—have not found it advisable to adopt them. Diagrams of the special ballast wagons of the Great Western, Lancashire and Yorkshire, North-Eastern, Great Northern, and Midland Great Western (Ireland) are given.

Further reference to special ballast wagons is made by Mr. Brown in the summary to his report, and there he observes that to get the best results from such a system it is advisable to have a good and steady central source of supply, seeing that, as a rule, the wagon cannot be used for any other purpose and everything should therefore be arranged with a view to their being kept in constant work.

American Practice.—Mr. Earl Stimson, chief engineer of maintenance, Baltimore and Ohio Railroad, is the reporter for America. His report (Bulletin of August, 1921) opens by saying that of sixty railways, having a total mileage of 152,000 miles, 75 per cent. have a divisional and 25 per cent. a departmental organisation—divisional means that an officer takes charge of the affairs of every department in a division, whilst departmental means that the whole line is departmentally governed from headquarters. The latter is the almost universal British practice.

Extra gangs are organised to do the heavy renewal work and other work outside the regular routine work of the section gangs. These are usually recruited from the most available source, generally the unemployed congregated about the larger cities. They are either hired individually or in gangs, usually gangs of foreigners of the same nationality. Under present-day conditions it is the opinion of the writer that twenty to twenty-five men is the limit for one foreman.

Economies from Reclamation.—Mention is made of reclamation plants at division headquarters, to which all used and scrap material is sent and carefully sorted. Material fit for re-use or that can be repaired

is reclaimed and issued on requisition in place of new material. Great savings have been effected thereby during the past five or six years on account of the high price of material and the uncertainties of delivery.

Scientific Management.—On two of the roads in the eastern states there has been developed a system of handling track work, using the principles of scientific management. A sufficient trial has been made to prove that, despite the diverse nature of track work, the greater portion can be measured by standard schedules and that the system can be successfully operated with resultant economies.

One of the many features contributing to uniform track maintenance conditions is an equitable distribution of the available force to the various sections. This is arrived at by accurately computing the equivalent mileage of each section and from a monthly inspection of the section to determine the condition per cent. of the principal items of maintenance work. From this percentage and the equivalent mileage the equated mileage is computed for each section, and this is used as the basis to determine the number of men required. The reporter then gives the relative values for one division determined from records of expenditure for a period of years.

Mr. Guiseppi Barbieri, of the Italian State Railways, has reported for the other countries.

Special Steels.

The question in this case was: Use of special steels, both for the track generally, and, in particular, for the track appliances—points, crossings, &c. Mr. W. C. Cushing, engineer of standards for the Pennsylvania system, has dealt with America; Mr. Mesnager, inspector-general of roads and bridges, Paris, reports for France; and M. Schrafl, of the Swiss Federal Railways, for other countries.

Mr. Cushing's report is a very long one, filling sixty-four pages of the June, 1921, Bulletin. Even then it is not complete, as it is more or less supplementary to that which he had prepared to be discussed at Berlin in 1915, which, by permission, was reproduced in the Bulletin of the American Railway Engineering Association, No. 177, of July, 1915. It opens by quoting a conclusion arrived at by the Congress when it met in Paris in 1900, that spring crossings or other appliances which do away with the gap at the frog—the American term for crossing—would be a considerable step in advance. At the Washington meeting in 1905 a conclusion was arrived at that the spring frog, used since the 'seventies in the United States, could be employed with perfect safety on all main lines carrying heavy traffic with axle loading on the locomotive of over 50,000 lb. and with loads on the rolling stock as high as 40,000 lb. per axle.

Mr. H. U. Mudge, of the Chicago, Rock Island and Pacific Railroad, should have been the reporter on road bed and track to the intended Berlin Congress, and in his report he said that the maximum axle loads then were 66,000 lb. for passenger locomotives and 61,000 lb. for goods locomotives. It was the opinion that the limit had been reached, but Mr. Cushing shows that this opinion was wrong, as the Pennsylvania has engines with an axle load of 75,600 lb.

Use of Manganese.—The special steel which is now most extensively used in the United States and Canada for frogs, crossings—the American term crossing applies to the track at crossings of two railways on the level—and switch points is manganese. Fourteen of the manganese frogs purchased by the Pennsylvania system in 1901 were still in use in the main tracks in 1912, and ten laid in 1903 had to be removed in 1916 when they probably still had a life of four years. After some very interesting metallurgical details which we cannot afford the space to reproduce, the report proceeds to say that, having finally recognised the valuable qualities of manganese steel for track work, the railway companies found that they were coupled with high cost, and they therefore instituted tests or experiments to determine the matter of economy. In many parts of the United States these economies have been well established and manganese steel is in regular use. In all places of extremely hard service such frogs are economical, and even necessary under present conditions, in order to avoid renewals where the traffic is so frequent that it is difficult to find an opportunity for repair work. The more difficult the place the more economical and indispensable is manganese steel.

Manganese rails have been very extensively used on the Boston Elevated Railroad and tried on other railways. Very good results are reported from the former, and Mr. Cushing says manganese steel rail will in all probability meet with greater favour among railway engineers when some of the objections have been removed. The principal faults found with it at the present time are:—(1) The elastic limit is low and a number of breakages has been recorded, which is disquieting. The ordinary rolled carbon steel shapes are difficult to reproduce in manganese steel on account of the trouble in quenching the metal without the formation of minute cracks which may subsequently cause fracture. (2) It is strong and tough, but the hardness is not superior to that of Bessemer steel, and consequently the resistance to battering at the ends of the rails is not altogether satisfactory. (3) The present primary cost is so high that although the resistance to wheel flange abrasion on curves is very great—greater than any other metal tried—the resulting economy is not sufficiently great to be attractive to railway administrations except in the most severe situations. (4) It is impossible to drill or cut it in the field on account of its great toughness. It is beyond the reach of present tools.

High-carbon Steel Rails.—The only administration which has sent in any information about high-carbon steel rails is the Pennsylvania. These rails have given excellent service from the standpoint of resistance to the abrasive action of wheels, lasting more than twice as long as ordinary Bessemer and open-hearth rail under similar conditions of traffic, but have developed serious fault from the standpoint of safety as the, breakages have been numerous—1 in 14 rails laid—and, most alarming of all, the silvery oval spot, called the transverse fissure, has been found in the head. The carbon was very high for rails weighing 85 lb. per yard—from 0.80 to 0.88 per cent.—and, in addition, nickel and chromium were present, making a very hard and brittle material, and it is not known what the effect might be in the case of rails of heavier section.

Mr. Cushing's "conclusions" include the observation that further study of the qualities possessed by high silicon rails, *i.e.*, steel with over 0.30 per cent., is advisable. He says also that heat-treated rails and those manufactured with the assistance of the electric process are at present in experimental use only, but the possibility of future value is promising and the study should be continued.

No illustrations accompany Mr. Cushing's report.

Reinforced Concrete Gas Producer.

An experimental reinforced gas-producer, of which we give an engraving in Fig. 1 and a sectional drawing in Fig. 2, has been built in Italy by the Costruzioni Cementizie of Florence for the Mineraria ed Elettrica del Valdarno Company, in accordance with the patents of Mr. O. R. Verity.

Referring to Fig. 2, it will be noted that the producer is a body of reinforced concrete which is of inverted bell shape and which is suspended from a ring F. The ring rests on legs A. The lower part of the bell is furnished at the bottom with a reinforced concrete ring M, on which rests the refractory lining of fire-bricks C. The space G between the fire-bricks and the reinforced concrete bell is

FIG. 1—VERITY REINFORCED CONCRETE GAS PRODUCER

filled with light perforated bricks so as to equalise the heat transmitted to the reinforced concrete bell. In the centre of the lower opening of the concrete bell is arranged a concrete base N, which rests on the main foundations at the bottom of the water seal tank, and on which is fixed a conical grate I, a layer of refractory material O being inserted between the support and the concrete, which only just reaches above the level with the water in the sealing tank. Pipes for conveying air and steam to the grate are led up the centre of the base N, which is made hollow for the purpose. The base N is provided with a circular tray D, on which the ashes as they fall from the grate may rest under water, the shape of the tray being such that the ashes will not, of themselves, fall off and will thus sustain the fuel in the producer. The shape of the base where it joins the tray is, however, such as to allow an easy descent of the ashes on to the tray. To remove the ashes and make them fall into the water tank below, a hydraulic device is brought into action. The latter is formed by a set of pipes E which is divided into sections and from which water is expelled under pressure through nozzles. The arrangement is such that the sections may be made to operate either simultaneously or independently, so that it is possible either to expel the ashes from the tray all round at once or at one or more places if it be found necessary to lower the fire zone at any particular point so as to straighten the fire. The ashes as they fall into the water seal tank are extracted by an elevator.

The producer was put into regular service to supply gas to a Babcock boiler of 600 square metres heating surface, and to perform the work it consumed normally 8 tons of lignite per hour. The analysis of the lignite used was as follows:—Water, 50 per cent.; ash, 20 per cent.; fixed carbon, 10.57 per cent.; volatile matter, 18.88 per cent. On overload the apparatus was worked at the rate of from 10 to 11 tons per hour.

The apparatus was submitted to the following explosion and temperature tests. For the first, an iron plate of over 60 kilos.—132 lb.—in weight, which was placed on the producer as a safety valve and cemented down, was blown 20 m.—say, 65ft. 6in.—from the producer. The

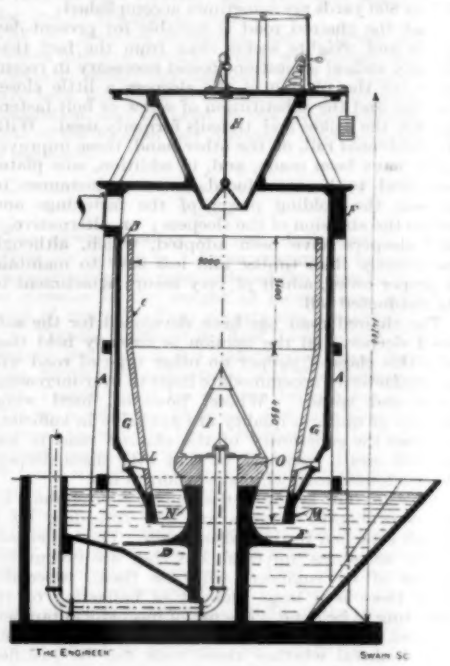


FIG. 2—SECTION OF VERITY GAS PRODUCER

bell of the producer did not suffer in any way, and Mr. Verity claims that explosions have less effect on cement than on iron. The temperature test was carried out as follows:—The producer was loaded with 80 tons of lignite and the water seal was removed. After twelve hours all the lignite was in complete combustion and flames escaped from the top opening of the producer. The top or cover of the producer attained in these abnormal conditions a temperature of 300 deg. Cent., and the bell 160 deg. Cent. in its hottest part. In normal running conditions the bell does not attain to a higher temperature than from 20 to 30 deg. Cent. above the surrounding atmosphere, while the top, or roof, of the apparatus reached a temperature of 60 deg. Cent.

Mr. Verity states that the ability to use reinforced concrete in gas producer construction allows of an economy in first cost of over 50 per cent. as compared with a metal construction, and that for outdoor work there is also a considerable economy in the maintenance of a plant made of reinforced concrete.

PORT DEVELOPMENT IN CHILE.

The President of the Republic of Chile has been authorised to contract, by means of public tenders, for the completion of the harbour works and complementary works at Valparaiso; for complementary works at the port of Antofagasta; for the execution of repair works at the ports of Constitucion, Iquique, Talcahuano, Lebu, Puerto Saavedra and Valdivia; for the construction of a mole and wharf at Puerto Montt; and for the construction of a wharf and complementary works at Tomé and Pichilemu. The President is also authorised to contract for the construction of the railway from Los Sauces to Curico, of the railway which will join Parronal to the branch from San Fernando to Pichilemu and for the extension of the railway from Hualane to Constitucion. These railways can be contracted for only after the placing of the contracts for the port works at Constitucion. The tenders may be placed in Chile or abroad, first for Valparaiso and afterwards for the other works enumerated in the preceding article, within the indicated period of ten years. The prices for the respective contracts for construction are not to exceed the sums mentioned below:—£750,000 for Iquique; £750,000 for the mooring works and complementary works in the harbour at Antofagasta; £1,470,000 for Valparaiso; £900,000 for Constitucion; £920,000 for Talcahuano; £930,000 for Lebu; £400,000 for Puerto Saavedra; £1,090,000 for Valdivia; £150,000 for the construction of a mole and wharf at Puerto Montt; £40,000 for the construction of a wharf and complementary works at Tomé; £40,000 for the construction of a wharf and complementary works at Pichilemu; and £200,000 to begin the construction of the railway from Los Quenes to Curico, of the railway which will join Parronal with the branch from San Fernando to Pichilemu, and the extension of the railway from Hualane to Constitucion.

HURST CUPOLA AND CHARGING ELEVATOR

An Improved Foundry Melting Plant.

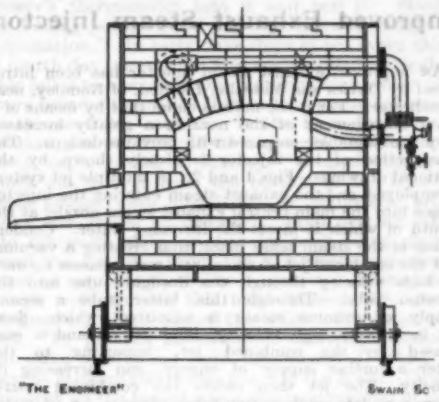
For the melting of cast iron for foundry purposes the ordinary foundry cupola is unsurpassed on the grounds of first cost, economy, rapidity of melting and convenience of operation. It has, however, several outstanding defects, which, although not of great importance in general foundry work, are distinctly objectionable in the production of molten cast iron for high-grade work. These defects have long been known, and different methods have been devised from time to time with the object of overcoming them either wholly or in part. The method of charging the cupola in layers of pig iron, scrap iron or scrap steel, isolated from each other by layers of coke, adds to the difficulty of ensuring uniformity in the composition of the metal, particularly when it is withdrawn in small quantities at a time from the cupola. In steel scrap mixtures, as is well known, the resulting improvement in mechanical properties produced by the addition of steel scrap is caused almost entirely by the reduced total carbon content of such mixtures as compared with direct mixtures of equal silicon content. The direct production of such mixtures, particularly in small cupolas, by melting the mixture under ordinary cupola conditions, with the molten metal lying in contact with the bed coke, often nullifies the advantages of the addition of steel scrap by reason of the opportunity presented for the complete absorption of carbon by the molten metal. The difficulty of producing mixtures of more than one grade, or of altering the composition for a comparatively small number of castings from cupola melted metal, is one which is well appreciated by every ironfounder.

With a view to overcoming these defects various measures are resorted to in the foundry. Special cupolas have been devised with an auxiliary chamber or "fore-hearth," as it is frequently termed, into which the molten metal runs from the cupola without lying amongst the bed coke. The fore-hearth, however, only partially meets the requirements of the ideal plant for the production of metal for high-grade castings. In many foundries the crucible melting process is used for the production of small quantities of high-grade metal, and in others the open-hearth furnace is employed if comparatively large quantities of special metal are required daily. The duplex process in which an electric furnace is combined with the cupola has been devised in America, and for the production of high-grade materials this process leaves nothing to be desired. On the score of initial and maintenance expense this process has, however, made no progress in this country.

The plant illustrated herewith was designed by Mr. J. E. Hurst for the regular production of high-grade cast iron for use in the manufacture of castings by the centrifugal casting process, as operated by Centrifugal Castings, Limited, Kilmarnock. The plant consists of a cupola, an elevator charging arrangement and an oil fired receiver.

The cupola is 28in. in diameter at the melting zone and is charged from the ground level by a bucket-type elevator which delivers through the ordinary charging hole. It has been frequently alleged that such an arrangement would prove unsatisfactory on account of the irregularity of the charging. In a cupola of a small diameter, however, the designer maintains that any irregularity of charging is of little moment, particularly as the molten metal is all collected in the bath. The height of the bed in the cupola has not been reduced, as it was desired to retain the option of operating the cupola in the ordinary manner for other purposes. There is, however, we are informed, no reason why the tuyere should not be brought down nearly to the level of the bottom of the cupola, thus reducing the height of the bed coke and effecting a considerable economy in the coke consumption. An auxiliary tuyere has been provided leading from the blast belt into the bottom of the bed coke. This tuyere is of use when starting up and also when pre-heating the bed in the early stages of the melt with the object of preventing the tap-hole, which is constantly open, from becoming stopped up with solidifying metal in the early stages of the melting operation. After the cupola has been in operation some time the auxiliary tuyere is stopped up. The cupola is provided with two tap-holes and spouts and the ordinary fettling door and drop bottom. One of the tap-holes is connected by a refractory-lined spout to the oil-fired receiver. The other tap-hole is provided for emergencies and for tapping off slag and metal previously to stopping the plant down for the meal hour.

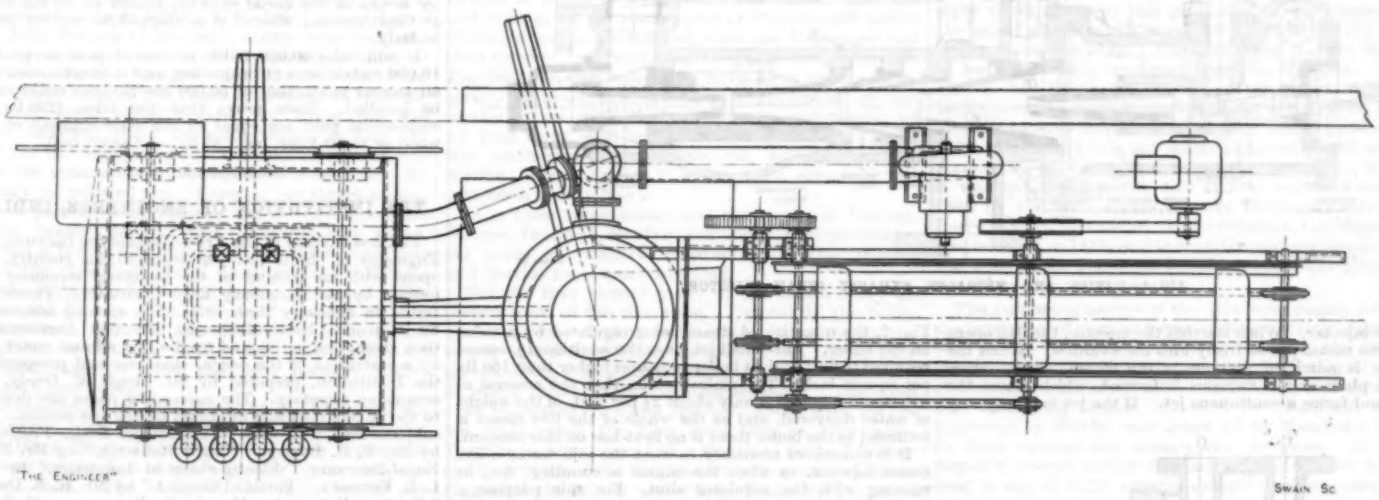
The oil-fired receiver consists of a shallow bath constructed of refractory brick and totally enclosed with a refractory roof. The bath is capable of holding 2 to 3 tons of liquid metal, and is provided with a large hole or breast for "fettling" and constructing the tap-hole, an inspection door, four holes for the oil burners and outlet ports The outlet ports are arranged to carry the hot waste gases out of the hearth chamber into a small chamber above the roof of the furnace whence they pass away into the air. The pipes leading the pressure air to the oil burners, at a pressure of 20in. to 25in. water gauge, are taken through this roof chamber, and during its passage through them the pressure air becomes heated, thus increasing the economy and efficiency of the burners. Oil is supplied to the burners by gravity feed from a tank supported above the furnace. The oil used at present is Shell-Mex .940 grade and is elevated to the tank by means of a small motor-driven rotary pump. The oil is passed through a gauze strainer before it is led to the burners. The inspection door is arranged to allow of samples of the metal to be taken for test and to permit the addition of pig iron or ferro-alloys to the bath. The breast is closed by a steel sheet held in position by a hinged spout not shown in the engraving. The tap-hole is constructed of black sand and coke, and on the completion of the melting operations the hinged spout is dropped, the steel breast plate removed and the tap-hole destroyed, when the slag and fused material can be raked out and the furnace properly fettled.



DETAIL OF OIL-FIRED RECEIVER

In practice the oil furnace is lit immediately after the bed of the cupola, and is raised to a sufficiently high temperature to receive the molten metal from the cupola by means of the full complement of burners. Whilst this process is in progress the cupola is charged and melting is begun. The molten metal runs direct to and collects in the hearth of the receiver. As the metal collects the burner power can be gradually reduced according to the quantity of metal being drawn from the receiver or the rate at which the molten metal is passing through the plant. When the metal is being drawn at full capacity one burner at considerably less than full capacity is, we understand, sufficient to maintain the metal hot, and if it is desired to maintain the metal in that condition for a long time the burner capacity can readily be adjusted to meet the requirements.

For the production of high-grade centrifugal castings it is necessary to be able to exercise control of the compo-



ARRANGEMENT OF CHARGING ELEVATOR, CUPOLA, AND OIL-FIRED RECEIVER

sition of the metal. This control in the case of the plant illustrated can be carried out by the introduction of mixings through the inspection door. The temperature of the metal is stated to be quite readily maintained, as may be judged from the fact that in the early stages of starting up the plant, as small a quantity as 10 cwt. of molten metal was retained at the correct casting temperature for as long a period as two hours. The maximum oil consumption with the burners open full bore is 27 gals. per hour. The full capacity is, as stated above, utilised only when starting from dead cold. The furnace can be raised to the correct temperature when working regularly in about half an hour. The average oil consumption of the furnace is reported to us as being about 30 gals. per cast of five hours, which figure gives an approximate oil consumption of 3 gals. per ton of metal on the full melting capacity of the plant over that period. The longer the melting period and the greater the output the lower is the oil consumption figure. Our thanks are due to Centrifugal Castings, Limited, for permission to describe and illustrate this plant.

Improved Exhaust Steam Injector.

An improved exhaust steam injector has been introduced by Davies and Metcalfe, Limited, of Romiley, near Manchester. For it the makers claim that by means of a novel arrangement of the nozzles, a greatly increased duty is obtainable compared with previous designs. The construction of the injector is clearly shown by the sectional drawings—Figs 1 and 2. A multiple jet system is employed, and the exhaust steam entering the injector passes into the main central exhaust steam nozzle, at the mouth of which it meets the incoming water. Condensation of the steam takes place, thus creating a vacuum, and the combined jet of steam and water passes forward at high velocity through the draught tube into the vacuum tube. Through this latter tube a second supply of exhaust steam is admitted, which, flowing in at very high velocity, impinges on and is condensed by the combined jet, imparting to the latter a further supply of energy, and increasing its velocity. The jet then enters the combining nozzle where complete condensation takes place, a jet of water at high temperature moving with high velocity being formed. After passing through the combining nozzle the jet enters the delivery nozzle, where its velocity is reduced, the kinetic energy being changed into pressure energy, and the jet leaving the injector passes through the delivery pipe into the boiler.

The injector consists of two casings A and B, bolted together. The first casing contains the exhaust steam valve, the supplementary live steam nozzle and steam inlet, and the auxiliary live steam inlet. The second casing contains the injector nozzles, the water regulator, the overflow and back-pressure valves and water and delivery connections.

The combining nozzle is constructed on the "flap" system, in which the nozzle is split longitudinally up to a point near the vacuum tube, where the bore is sufficiently large to permit an easy exit for the steam and water. This ensures the prompt starting and automatic working of the injector. When starting the injector, the flap opens and the steam passes freely into the overflow. When the water is admitted and meets the steam, condensation takes place and a vacuum is formed, which closes the flap and forms a continuous jet. If the jet is in any way broken, the pressure of the steam opens the flap and the steam escapes freely until a vacuum is again formed and the continuity of the jet is re-established. An automatic valve controls the admission of exhaust steam to the injector. It consists of a circular disc suspended from a hinge at the top so as to hang freely, as shown in Figs. 1 and 2, and offers no resistance to the passage of steam. It can be closed by a cam on the valve spindle so as to shut off any communication between the exhaust steam pipe and the injector, thus preventing the admission of exhaust steam when the instrument is not in use.

The spindle is coupled to a rod so that it can be easily operated from the footplate of the locomotive. The supplementary live steam nozzle mentioned above is of very small bore. It is fixed at the entrance of and concentric with the exaust steam nozzle and receives steam at boiler pressure by means of the passage shown in Fig. 2, the quantity of steam being regulated by a valve on the boiler. This small jet gives the additional pressure required to feed against boiler pressures higher than 150 lb. per square inch. The makers claim that the amount of live steam required is only about 2½ per cent. of the weight of water delivered, and as the whole of the live steam is returned to the boiler there is no heat loss on this account.

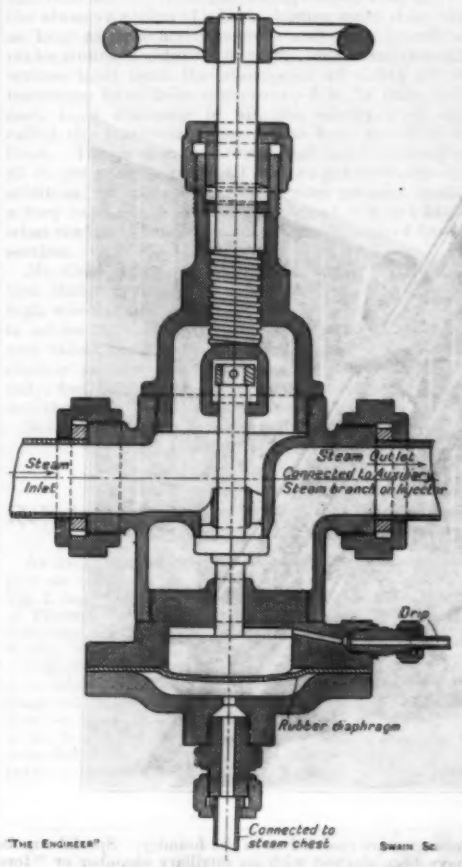


FIG. 3—AUTOMATIC STEAM VALVE

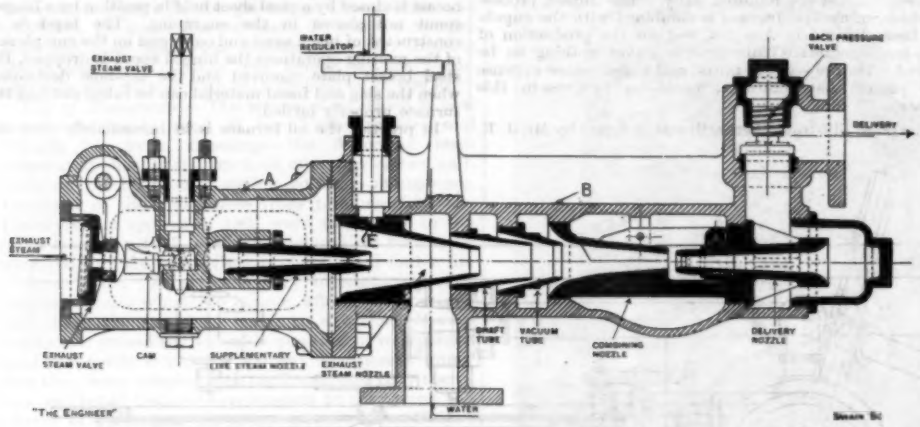


FIG. 1—DAVIES AND METCALFE EXHAUST STEAM INJECTOR

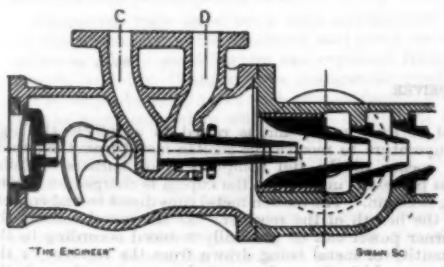


FIG. 2
ARRANGEMENT OF SUPPLEMENTARY LIVE STEAM NOZZLE

It is sometimes necessary to work the injector as a live steam injector, as when the engine is standing, &c., or running with the regulator shut. For this purpose a supply of live steam to replace the exhaust steam is introduced into the automatic exhaust valve casing through the auxiliary steam branch D—Fig. 2. It enters the injector through the annular space surrounding the supplementary nozzle, flows into the exhaust steam nozzles, replacing the exhaust steam, and the injector then works exactly as when exhaust steam is used. When thus working with live steam, the pressure of the steam in the automatic valve casing closes the exhaust steam valve, thus preventing the entrance of any air which would have a tendency to destroy the vacuum and so impair the working of the injector. It will thus be seen that to change over from exhaust steam to live steam working, it is only necessary to open the steam supply to the auxiliary steam pipe, when the injector will work as efficiently as before.

The water regulation of the injector is effected by varying the area for the entrance of water into the nozzles. This is done by moving the exhaust steam nozzle, so that the surrounding area between the end of the exhaust nozzle and the draft tube—Fig. 1—through which the water enters is varied, so regulating the quantity of water entering the injector. The exhaust steam nozzle can move to and fro in the casing, and the movement of the nozzle is regulated by the water regulator spindle. On the end of this spindle is an excentric pin E which fits into a steel die, moving in a slot which is cut on the outside of the exhaust nozzle. By turning the water regulator spindle, the nozzle is moved longitudinally in the casing, so regulating the quantity of water admitted to the injector. The injector is also fitted with an automatic overflow valve which, when the apparatus is working, seals the overflow chamber and prevents the admission of air. In starting or restarting, the valve opens freely so that the steam and water escape readily, so that the injector is very prompt in action. A self-contained back pressure valve is also fitted, and the nozzles are constructed of special bronze and can be easily removed for examination or cleaning by unscrewing the body cap nut.

The following figures show the delivery pressures at which this injector is constructed to operate, with the corresponding exhaust steam pressures :—

Exhaust steam pressures. lb. per sq. in.	Delivery pressures. lb. per sq. in.
1	150
3	165
5	180
10	210

Fig. 3 represents a sectional view of an automatic steam valve for use with exhaust injectors. The valve is designed to control the supply of live steam to work the injector when there is no exhaust steam, *i.e.*, when the regulator is shut. When the injector is operating with exhaust steam the automatic valve spindle is opened, but the steam valve is kept closed by live steam from the cylinder steam chest acting on the rubber diaphragm and piston shown. When the regulator is closed the steam chest pressure ceases to act on the diaphragm and the pressure from the boiler opens the automatic valve and keeps the injector working.

PEAT EXPLOITATION IN ITALY.

The exploitation of Italian peat beds has commenced in earnest, additional plant having recently been erected to deal with the important deposits situated in the mountainous district of Laga, which are 1300 m. (say, 4250ft.) above sea level. Before the war, owing to the comparatively low price of coal, it was not considered remunerative to work these deposits; but now, owing to high freight charges and exchange rates and to the increased cost of labour, the enterprise is again being taken up. The beds under exploitation extend as far as the swamps of Mascioni and Poggio Cancelli. They cover an area of over 6000 acres and vary between about 20ft. and 45ft. in thickness, the total volume of peat being estimated at 50 million cubic metres.

The works erected, and to be erected, comprise the latest machinery for excavation and working the peat, the construction of shelters for the many workmen employed, stores, restaurants and co-operative ovens for the use of the workmen, and the laying of railway lines and transport of equipment for the transfer of the peat from the points of excavation and drying to where the material is worked up into a marketable product. Other improvements in hand include the construction of an aerial railway in connection with the Capitignanao-Aquila Railway, which is to be capable of handling 800 cubic metres of peat products every ten hours. After excavation, the peat is macerated by 45 horse-power Strenge engines, and subsequently worked up by groups of Bühler machines, which obtain their steam from Tosi boilers. After being dried, the peat is to be shaped into small briquettes, and, by means of the aerial railway, loaded on to the trains at Capitignanao, whence it is shipped to various points in Italy.

It will take 60,000 cubic metres of peat to produce 10,000 metric tons of briquettes, and it is estimated that an annual production of 50,000 metric tons could easily be handled. Tests prove that 100 kilos. (220 lb.) of commercial peat are equal to the same amount of dry wood or to 40 kilos. (say, 88 lb.) of Cardiff coal.

THE INSTITUTION OF ENGINEERS, INDIA.

The first volume of the Proceedings of the Institution of Engineers of India has just reached this country. It opens with an account of the inaugural ceremony performed by his Excellency Lord Chelmsford, Viceroy of India, on February 23rd, 1921. The opening address by Sir Rajendra Nath Mookerjee, the first President, is then given, and is followed by the first annual report and by a statement of the origin, character and prospects of the Institution, prepared by Mr. Hugh W. Brady, the organising secretary. The succeeding pages are devoted to the papers read and discussed during the session. The subjects dealt with were "The Howrah Bridge Problem," by Mr. F. R. Bagley; "Light Railways," by Mr. F. G. Royal-Dawson; "Electro-chemical Industries," by Mr. L. L. Fermor; "Portland Cement," by Mr. H. F. Davy; "Driving Belts," by Mr. A. T. Weston; and "The Patent System," by Mr. V. Lough. The first-named paper is accompanied by a number of folding plates. The volume is well produced, but we feel some regret that the Institution has adopted a size which differs a little from that used by the engineering institutions of this country. We venture to suggest that, if possible, the slight alteration that is necessary might be made in future volumes to bring them to the standard size of the Institutions of Civil and Mechanical Engineers. Fortunately, the margins of the first volume are such that it could be trimmed down to conform with later volumes without loss, save of a little appearance.

The building of a big dam on the river Ouareau, in the Laurentian Mountains, near St. Agathe, by the Quebec Government, at a cost of 250,000 dols., is provided for in a Bill which passed the Legislature a week or two ago.

The Newcomen Society.

ON Thursday evening, March 30th, Engineer-Commander Edgar C. Smith presented a long and informative paper entitled "The Centenary of Naval Engineering," at a meeting of the Newcomen Society, in the building of the Institute of Marine Engineers. From it we take the two sections which follow.

Commander Smith gave his paper the title which it bears because it is just one hundred years since the first steam vessel, H.M.S. Comet, constructed in a Royal Dockyard, was launched. In the first part of his paper he referred to the introduction of steam vessels into the Navy, and to the development of the paddle-wheel vessel as a warship; other sections were devoted to the rise of the engineering branch of the Navy, and to the progressive substitution of steam vessels in place of the old sailing ship. A notable feature of the paper is presented by two extensive tables, the first giving particulars of the paddle dispatch vessels, mail packets, tugs and sloops of less than 200 nominal horse-power added to H.M. Navy during 1820 and 1850, and the second providing particulars of paddle-wheel warships of H.M. Navy of 200 nominal horse-power and over in the period 1832–1851.

It will be observed that Commander Smith dealt only with paddle vessels. It is to be hoped that on a future occasion he will complete the history by describing the development of screw steamers. He presented his paper as a lecture, liberally illustrated with lantern slides.

EARLY MARINE ENGINE BUILDERS.

In his review of the progress of marine engineering, contained in his presidential address to the Institution of Civil Engineers in 1846, Sir John Rennie mentioned as being among the pioneers of this branch of industry Boulton and Watt, Maudslay, Field, Robert and David Napier, Miller, Ravenhill, Seaward, Rennie, Scott, Fawcett, Penn, Jessop, Glynn, Barnes, and others. Nearly all of these contributed also to the development of naval engineering. Boulton and Watt had built the engines for the Congo in 1816, and to them went many of the earliest orders. The Butterley Ironworks, of Derby, with which Jessop, Miller, Barnes, and Glynn were associated, also built some early engines. But it is neither to these famous old English firms or to the birthplace of the steamboat—the Clyde—that one turns to trace the history of the man-of-war's steam engine, but rather to the banks of the Thames. First in the field came Henry Maudslay (1771–1831), who, having made a reputation at his works near Oxford-street, London, founded in 1810 the works at Westminster Bridge-road. Four years before this he had been joined by Joshua Field (1787–1863), and ultimately four of Maudslay's sons were connected with the works. To Joseph Maudslay (1801–1861), the fourth son, belongs the credit of reviving interest in the oscillating engine, and in 1839, with Field, he patented the twin-cylinder engine, which was extensively used. He also brought out the annular engine, an example of which was to be seen in H.M.S. Princess Alice. Charles Sells (1820–1900), said to be the most successful designer of marine engines of the last century, joined Maudslay's in 1837, and in 1847 was the first head of the designing department. Twelve years after Maudslay moved to Lambeth. Joseph Miller (1797–1860) joined hands with John Barnes (1798–1852)—they were both old Soho apprentices—and in 1822 opened a shop at Glasshouse Fields, Ratcliff. In 1824 John Seaward (1786–1856) founded the Canal Ironworks at Millwall. The first naval vessel engined by Miller was the Blazer, Seaward about the same time obtaining the order for the engines of the Volcano. Seaward was one of the most progressive engineers of his time. He not only introduced the "Gorgon," or direct-acting, type of paddle-wheel engine, but he developed the tubular boiler, devised brine nozzles and tanks, invented a telescopic funnel, and for some years was one of the chief builders of naval engines. Miller's services were also of a pioneering character. His partner left him in 1835, Barnes afterwards playing an important part in the development of steam navigation in France. Miller was then joined by Ravenhill, and in 1846 the firm became Miller, Ravenhill and Salkeld.

The connection of John Penn (1805–1878) with the Navy began with his offer to re-engine the Admiralty yacht Black Eagle (late Firebrand) with engines of the same weight, but of much greater power than the original ones. The story of the reception of his uninvited tender is found in the autobiography of Sir John Rennie. This was in 1843, and the association thus began lasted Penn's lifetime. His reputation was second to none, and his services to the country during the Crimean War were of the highest order. Penn's works at Greenwich had been founded by his father about 1800. Of the other London marine engine builders, mention may be made of George Rennie (1791–1866), who, in the Holland-street Works at Blackfriars, built engines for the Samson, Bulldog, and Oberon; and of Edward Humphrys (1808–1867), who, after holding the post of Chief Engineer of Woolwich Dockyard for two years, in 1852, with Tennant and Dykes, founded the Deptford Pier Works. Humphrys, however, supplied no engines for paddle-wheel warships.

Of other marine engineers connected with the Navy, Robert Napier (1791–1876), of Glasgow, has already been referred to in connection with the Stromboli and Vesuvius. He also engined the Thunderbolt and Harpy, and built and engined the three iron paddle-wheel gunboats Bloodhound, Jackal, and Lizard. His right-hand man for many years was David Elder (1785–1866), the father of John Elder. Scott and Sinclair, also of Glasgow, supplied the machinery for the Hecate, Hecla, and Spiteful. Fairbairn, of Manchester, built the direct-acting engines for the Vulture, Odin, and Sidon; Fawcett, of Liverpool, built the engines of the Inflexible, Medusa, Medina, and Merlin; while Rigby engined the Fury.

Of the 25,000 total nominal horse-power of the vessels in Table II., the collective nominal horse-power of Penn's engines was 2070, of Miller's 2860, of Maudslay's 4370, and of Seaward's 6770.

NAVAL ENGINEERING DURING THE 'THIRTIES AND 'FORTIES.

Though sea-going engineers have never, to any extent, been given to writing steam manuals or recording their experiences, there were in the early days of the steam Navy many naval officers not engineers themselves, who took a great interest in steam and who not only studied Tredgold and turned up their sleeves in Napier's and Seaward's shops, but who fortunately wrote works on the marine steam engine. In 1828, the year before he sailed north in the little steamer Victory, fitted with Ericsson's heartbreaking novelties in the way of imperfectly tried machinery, Captain Sir John Ross published his "Treatise on Steam Navigation." His experiences with the Victory's engines are, however, contained in his "Narrative of a Second Voyage in Search of the North-West Passage," published in 1835. The ship left Gravesend May 23rd, 1829, and in October of that year, so troublesome had the machinery been, that it was taken out, lock, stock and barrel, and stored on Fury Beach, where it possibly lies to-day. Next to Ross's book on the steam engine came that by Commander Robert Otway, entitled "An Elementary Treatise on Steam." There were three editions, which appeared in 1832, 1834, and 1837. Otway had held command of the Comet and the Echo, and it was while he was captain that the Echo had her high-pressure boiler fitted.

In 1838 we have the first literary effort of a naval engineer—the memoir, "On Marine Boilers," by John Dinnen, who may be termed the father of naval engineers. The essay contained the outcome of his experiences as chief engineer of the Lightning (1828–1831) and African (1831–1836). Following Dinnen came Commander Spencer Robinson, afterwards Controller of the Navy, with his book, "The Nautical Steam Engine" (1839). That same year Captain Basil Hall, writing in the *United Service Magazine*, advises young officers to turn their attention to steam, and tells them to take off their coats and put on paper caps and submit to the companionship of thorough-going workmen in Maudslay's and Napier's workshops. In 1843 Captain W. J. Williams, who had lectured on steam in the Royal Naval College at Portsmouth, published "A Steam Manual for the British Navy," and two years later Lieutenant W. E. Gordon published "The Economy of the Marine Steam Engine," in which are to be found some particulars of the Driver, in which he went round the world. Lectures had been given for some years at Portsmouth before Williams wrote his manual, and the Messenger and then the Bee had been used for practical instruction. The first lectures appear to have been given voluntarily, but about 1841 Thomas Brown, one of the first to rise to the rank of chief engineer, was appointed for that duty, and in 1847, with Thomas J. Main, the mathematical professor, he published "The Marine Steam Engine," which long remained the text-book for the Navy.

It is from these books and the works of Murray, Bourne, Tredgold, Hoblyn, and others, that the following notes on practical engineering in the 'thirties and 'forties have been compiled.

For the first twenty years of the steam Navy all boilers were of the flue type. Externally the boiler was box-like. Boilers were often shaped to fit the vessel. In a flue boiler the gases from the furnace passed along a winding passage, the ceiling and walls of which provided the heating surfaces. The flues were separated by water spaces. These were 4in. or 5in. wide, while the flues were 16in. or 17in. wide. The flue in some cases had a length of 60ft. Leakage at the bottom of the flue was very frequent. Dinnen suggested cementing and tiling, Maudslay proposed tinning the bottom plates. Flue boilers were structurally weak, they were heavy, contained a great volume of water, and were only fit for very low pressures. Sometimes the whole boiler was constructed of copper. The height of the water was shown by a copper float and indicator, then by glass tube gauges. Safety valves were always of the deadweight type. They could usually be lifted by hand. The waste steam pipe ended in a rose and bulb arrangement to prevent the condensed steam falling on the crew and paint work. Reverse valves or internal safety valves were fitted to prevent the formation of a vacuum in the boiler. Pressure and vacuum gauges up to the 'sixties were iron U tubes, partly filled with mercury, on the open end of which rested a float. When a boiler was to be tested, oatmeal or similar substances were used in considerable quantities. Dinnen remarks on the numerous "weeps" and "channels," of which no notice was taken. Tubular boilers when first fitted were criticised, because the flaming at the funnel which occurred was dangerous to the rigging of a ship being towed alongside. The pressure in use remained very low. From 3½ lb. it gradually increased in forty years to 20 lb. Especially interesting on this point is the paper read by Seaward to the Institution of Civil Engineers in 1849, "On the Employment of High-pressure Steam Working Expansively." The discussion was taken part in by Rennie, Scott Russell, Farey, Perkins, Joshua Field, and other stalwarts of that heroic age. The Admiralty had asked the opinion of various makers, and Seaward had recommended that "the steam employed in the Navy should not be of greater pressure than 10 lb. per square inch." This accorded more or less with the general view.

The successful working of these low-pressure boilers with salt water called for great care. Blowing down was of the first importance. Instructions in 1844 said the engineer was to draw off a small quantity of water in a saucepan. "He is then to dip a common brewer's thermometer into it and boil it. Should the boiling point exceed 215 deg. there is danger of incrustation." In early days ships at sea every third or fourth day put out the fires and emptied the boiler. This fell into abeyance and blowing down every two hours became the rule. Dinnen lays particular stress on the need for caution. If the blow-down cocks jammed, the water could be blown through the hand pump, or, according to Murray, "a usual plan is to knock out a rivet from the bottom of the boiler." Brine pumps were introduced by Maudslay, brine tanks and valves by Seaward. Feed heating came into use quite early, an annular tank being placed round the funnel. From this the water sometimes found its way into the boiler by gravity. When brine pumps were in use the brine passed through a refrigerator, which cooled the brine and heated the feed. To prevent incrustation, charcoal, sawdust, and other substances were recommended, while to prevent priming tallow was put into the boiler. Firing a musket up the funnel was a common method of dislodging the soot.

For the first twenty years naval vessels had side lever engines. Napier continued to build such engines for Atlantic liners till 1860. These engines were reliable, but took up much space and were heavy. Pistons at first were packed with "cinnet." The long D slide valve invented by Murdock was balanced and was driven by a loose excentric. Stopping and starting was done by moving the slide by hand. Jet condensers were the rule, and a vacuum was obtained by filling the condenser with steam through the blow-through valve and then turning on the injection. The snifting valve which allowed the air in the condenser to escape when the condenser was flooded with steam was first placed in the air pump. David Elder removed it to the condenser. It was placed low down and could on occasion be fixed open so that the air pump could pump out the bilge. The regulation of the injection water had to be carefully attended to. Lines were scored across the frames to test whether the engines remained in line with one another. The parallel motion, the valve levers, the stops on the shaft all provided problems for the engineer-in-charge. Fresh water for the use of the crew was obtained from the cylinder jacket. The African dispensed with eight water tanks by this plan, and Otway suggested the use of a tank and a pump for distributing this hot water about the ship. The first vessel in the Navy to have a surface condenser was the Megaera. She had the five-fold combination—an air pump, a circulating pump, a surface condenser, an evaporator, and a steam saver—according to Samuel Hall's patent of 1836. At first it was not worked correctly, but after Hamshaw, of Malta, had taken the matter in hand it was quite successful, and it was reported on in 1842 by the triumvirate of early naval engineering, Parry, Ewart, and Lloyd. Unfortunately, the Megaera was wrecked in 1843, and though the surface condenser was tried in the Penelope, it did not come into general use till twenty years later.

The cumbrous nature of the side lever engine led to the invention of various types of direct-acting engines, such as the "Gorgon" engine of Seaward, the twin-cylinder engine of Maudslay, the direct-acting engine of Fairbairn, Miller, Boulton and Watt, and others. The oscillating engine invented by Murdock, and improved by Manby, was taken up by Maudslay, but its final success was mainly due to Penn. David Napier's steeple engine does not appear to have been used in any of H.M. vessels, except the Firequeen.

Usually the common type of paddle wheels was used. Feathering paddles were fitted in various ships, as also was the cycloidal wheel of Field, in which the paddle boards were divided into strips and arranged on the arm in a cycloidal curve. It being of paramount importance that all war vessels should maintain their sailing qualities, the reefing of the paddle floats, the unshipping of the floats, or the disconnecting of the paddle wheels so that they were free to revolve, were matters of considerable importance, and much attention was paid to this. Braithwaite, Seaward, and Maudslay all introduced methods of disconnecting. Brakes were also fitted for holding the paddle wheels when required, while quite a number of officers expended ingenuity in designing paddle-box boats which were carried upside down over the paddle wheels.

Safety Practice for Mine Hoisting Ropes.

THE results of an inquiry as to mine cables and hoisting methods, made by the American National Safety Council were given by Mr. R. M. Raymond in a recent bulletin of the American Institute of Mining and Metallurgical Engineers. The replies came largely from metal mines. The depth in most cases was from 1000ft. to 1500ft., but in a number of mines it was 2000ft. to 3000ft. The loads range from 7 to 17 tons, with a balanced weight of 4 to 7 tons. Hoisting is done generally in balance, with a few companies using counterweights. In only half of the cases were the drums grooved, and in very few cases were the drums capable of holding all the rope in a single wrap. But most of the replies indicated that a single wrap is desirable if possible, and two wraps are considered the limit of good practice. Too few mine operators attach proper importance to the distance at which the engine is set from the shaft and the fleet angle between the drum and the head sheave. The matter of overwind and underwind of rope also receives too little attention. According to Mr. Vaughan, of the South African Mines Department, experience in that country inoicates that the rope which underwinds wears 20 per cent. more rapidly than that which overwinds, and that the average life of the rope is prolonged by alternating the rope on the drums.

A few shallow mines use a small drum and large head sheave. But in all cases the diameters of drum and sheave should be not less than that recommended by the rope manufacturers and at least sixty to one hundred times the diameter of the rope, or one thousand times that of the largest wire used. In a majority of cases the sheaves are of cast iron, turned true and $^{1}/_{16}$in. or $\frac{1}{8}$in. larger than the rope. In several cases a removable cast iron lining is used for the groove, the best design being that of the Nordberg sheave. Several other companies use hardwood blocks, preferably maple. A few use hemp packing at first or to fill the groove when the sheave becomes worn. More attention should be given to the material of sheaves and to the use of linings.

Wire ropes vary in size from 1in. to 1¼in. and are generally 6 by 19 with a hemp centre. A majority of the mines use the higher-class rope, plough steel or special improved brands. A few use a flattened strand 6 by 25. The Lang lay is preferred by large mine operators hoisting from the greater depths. Lang lay ropes are used in 90 per cent. of the cases noted in South Africa; they are in very general use in Australia and are becoming more general in the United States.

Specifications for rope are used only by a few mines, reliance being placed on the tensile strength given by the manufacturers. For plough steel it is understood that the tensile strength of the wires is about 200,000 lb. per square inch. The International Nickel Company, in calling for tenders from manufacturers, gives a full description of working conditions and asks manufacturers to recommend rope for those conditions. It requires a factor of safety of 7 for hoisting ore and of 10 for the man hoist. The United Verde Mine stipulates low-phosphorus steel, high carbon and manganese, with a tensile strength of the wires of 200,000 lb. per square inch. The Copper Range Company stipulates for 1¼in. plough steel, 6 by 19, regular lay, 58 tons tensile strength, and on test has found the rope to have a strength of 75 tons. The Broken Hill Mine uses 1¼in., 6 by 19, Lang lay and specifies a breaking stress of the rope of 60 tons and best flexible plough steel or its equivalent.

Although the manufacturers' recommendations seem to be generally satisfactory, it is important that purchasers should state their working conditions, nature of shaft lining, whether acid mine water or harmful gases are encountered, and what factor of safety is desired. The factor of safety stipulated or estimated varies considerably, but as a rule the manufacturer's figure is taken as satisfactory, and this is usually 5 or 6 for new rope. For worn rope the factor varies from 3½ to 5, and these variations for discarding the rope correspond somewhat with the speed and depth.

None of the mine laws of the several American States indicate a factor of safety. The Canadian mining law, however, requires 6 for ropes in shafts less than 2000ft. deep and not less than 5 for shafts up to 3000ft. deep. This law also requires a certificate from the manufacturer, showing date of manufacture, size, weight, number and size of wires, class of core, breaking stress of steel wire, and estimated breaking load of rope. This certificate is recorded and is supplemented by records of the rope when in use.

Returns as to the rope speeds vary from 600ft. to 1000ft. per minute in the shallower shafts and from 1600ft. to 3000ft. per minute in the deeper shafts. When hoisting men the speed is limited usually to 400ft. or 600ft. per minute, but in a few cases it runs as high as 1000ft. Acceleration varies considerably, depending on the depth. Inspection of ropes ranges from daily to weekly, but 70 per cent. of the returns report daily inspections, while one mine reports three inspections daily when hoisting men.

In limiting the service life of ropes there is considerable diversity. One iron mining company turns the rope end for end after six months and discards it after twelve months. The International Nickel Company takes special care of its ropes, but abandons them after two years' use even if they are apparently in good condition. Several mine operators discard rope when the wires on the outside of the strands are worn to less than 60 per cent. of the original area or when inspection shows signs of corrosion. Others take more particular note of the number of broken wires. One company discards rope when the number of broken wires in any consecutive 10ft. exceeds 10 per cent. of the total wires in the rope. Another very careful company condemns the rope when twelve broken wires are found, or if the wires are pitted and can be prised out of place easily, even if no broken wires are found. Still another company discards rope when sixty or seventy wires are broken in one strand.

Decrease of diameter is the cause of discard in some cases; in one case the limit is $^{3}/_{16}$in., and in another case it is ¼in. In the latter case it has been found that ropes groove the sheaves if left in service when reduced ¼in. in diameter. The Anaconda Copper Company, in the United States, discards when 20 per cent. of the strength has been lost by abrasion and broken wires. The Sulphide Corporation, New South Wales, discards its 6 by 7 ropes when one wire in any way shows fractures; the ropes are discarded after two years' use even if they appear in good condition.

LAUNCHES AND TRIAL TRIPS.

GORILLA; built by Harland and Wolff, Limited; to the order of Coast Lines, Limited, for G. and J. Burns, Limited; dimensions, 208ft. by 31ft. by 14ft. 3in. Engines constructed by the builders; delivered, February 7th.

FU KWANG, steamer; built by Rotterdamsche Droogdok Maatschappij; to the order of Anglo-Saxon Petroleum Company; dimensions, 257ft. 6in. by 37ft. by 17ft.; to carry 1000 tons; launch, February 8th.

CYNTRIANA; built by Irvine Shipbuilding and Dry Docks Company, Limited; to the order of Furness, Withy and Co., Limited; dimensions, 435ft. 6in. by 35ft. by 30ft. 7in. Engines, triple-expansion, 29in., 49in. and 80in. by 54in. stroke; constructed by Richardsons, Westgarth and Co., Limited; trial trip, February 12th.

RIO BLANCO, single deck; built by Blyth Shipbuilding and Dry Docks Company, Limited; to the order of Thompson Steam Shipping Company, Limited; dimensions, 377ft. by 53ft. 2½in. by 28ft. 9in. Engines, triple-expansion, 26in., 43in. and 73in. by 48in. stroke; constructed by North-Eastern Marine Engineering Company, Limited; trial trip, February 13th.

BRITISH GRENADIER, oil tank steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of British Tanker Company, Limited; dimensions, 455ft. by 57ft.; to carry 10,000 tons. Engines, double-reduction geared turbines, Metropolitan-Vickers Rateau type; constructed by the builders; launch, Tuesday, February 14th.

SCOTTISH CASTLE, two-deck; built by Sir W. G. Armstrong, Whitworth and Co., Limited; to the order of Tankers, Limited; dimensions, 440ft. by 57ft. 2in. by 33ft. 11in.; to carry 10,100 tons deadweight. Engines, direct-acting surface-condensing triple-expansion marine type, 27in., 46in. and 77in. by 51in. stroke; launch, Tuesday, February 14th

GLENGARRY, twin-screw vessel; built by Harland and Wolff, Limited; to the order of Glen Line, Limited; dimensions, 502ft. by 62ft. by 38ft. 6in.; to carry 9460 tons. Engines, eight-cylinder four-cycle Diesel crosshead type; constructed by the builders; launch, February 23rd.

BRITISH SERGEANT, geared turbine oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Limited; to the order of the British Tanker Company, Limited; dimensions, 415ft. by 54ft. by 33ft.; to carry 8400 tons deadweight. Engines, single-screw double-reduction geared turbines of Parsons' impulse and reaction type, pressure 200 lb. Howden's forced draught fitted; constructed by the builders; launch, Monday, February 27th.

MOJOKERTO, geared turbine steamer; built by William Gray and Co. (1918), Limited; to the order of William Ruys and Zonen; dimensions, 451ft. by 57ft. by 32ft. 10in.; to carry 11,500 tons deadweight. Engines, double-reduction geared turbines, Parsons' type; constructed by the builders; launch, February 27th.

HOWRA, standard "N"; built by Sir W. G. Armstrong, Whitworth and Co., Limited; to the order of the British India Steam Navigation Company, Limited; dimensions, 411ft. 6in. by 55ft. 6in. by 38ft. 1¼in.; to carry 10,400 tons deadweight. Engines, Parsons geared turbine type; constructed by the builders; launch, February 27th.

RONALDSHAY, large cutter suction pump reclamation dredger; built by Wm. Simons and Co., Limited; to the order of Sir J. H. Biles and Co., for the Indian Government. Engines, vertical compound surface-condensing, pressure 180 lb.; constructed by the builders; launch, February 28th.

RALLUS, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Cork Steamship Company, Limited; dimensions, 290ft. in length by 42½ft. beam; to carry 3100 tons deadweight. Engines, triple-expansion; constructed by the builders; launch, Wednesday, March 1st.

CANTILEVER-FRAMED steamer; built by Sir Raylton Dixon and Co.; to the order of La Cie. des Chemins de Fer de Paris à Lyon et à La Méditerrannee; dimensions, 400ft. by 56ft. by 31ft.; to carry 8900 tons deadweight. Hull and machinery constructed by La Ste. Nationale d'Affrètements et Eyres et Bryers; launch, Thursday, March 2nd.

DIOGENES, twin-screw cargo and passenger vessel; built by Harland and Wolff; to the order of Geo. Thompson and Co., Limited; dimensions, 500ft. by 63ft. by 35ft. 3in.; to carry 12,300 tons. Engines, Brown-Curtis compound turbines; launch, March 2nd.

BRITISH MARINER, oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Limited; to the order of the British Tanker Company, Limited; dimensions, 440ft. by 57ft. by 33ft. 11in.; to carry 10,200 tons deadweight. Engines, single-screw double-reduction geared turbines, pressure 200 lb.; Howden's forced draught fitted; constructed by the builders; trial trip, Thursday, March 2nd.

REGINA, liner; reconditioned by Harland and Wolff, Limited; to the order of the White Star Line Company; dimensions, 600ft. 9in. by 67ft. 6in. by 45ft. 6in.; to carry 16,000 tons. Engines, four-crank triple-expansion, 28in., 44in. and 49½in. by 4ft. 6in. stroke, pressure 215 lb.; left port, March 2nd.

HELENA, steel screw steamer; built by Craig, Taylor and Co., Limited; to the order of A. C. Lensen; dimensions, 337ft. by 48ft. by 24ft. 3in. Engines, 24in., 39in., and 64in. by 42in. stroke, pressure 180 lb.; constructed by North-Eastern Marine Engineering Company, Limited; trial trip, Wednesday, March 8th.

BRITISH OFFICER, two-deck; built by Palmer's Shipbuilding and Iron Company, Limited; to the order of the British Tanker Company, Limited; dimensions, 440ft. by 57ft. by 33ft. 11in.; to carry 10,200 tons. Engines, single-screw double-reduction geared turbines of Parsons' impulse and reaction type, pressure 200 lb.; Howden's forced draught fitted; constructed by the builders; launch, Tuesday, March 14th.

BURDWAN, cutter suction pump reclamation dredger; built by William Simons and Co., Limited; to the order of the Indian Government. Engines, compound surface-condensing, pressure 120 lb.; constructed under the direction of Sir J. H. Biles and Co.; launch, March 17th.

ALSINA, twin-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of Société Générale de Transports Maritimes à Vapeur; dimensions, 470ft. by 58ft. by 34ft. 3in. Engines, double-reduction gearing of the Metropolitan-Vickers Rateau type; constructed by the builders; trial trip recently.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The Lock-out.

THERE is little change in the industrial situation in this area on the week, owing to the engineers' lock-out. Such interruption of manufacturing activities as has resulted in the workshops is hardly apparent yet in the distributive channels of trade, but the situation becomes more difficult every day. At some factories men belonging to the allied unions have ceased work in consequence of the holding up of necessary material through the lock-out, but the number is not believed to be large. At the time of writing the position is changing hourly, and it is difficult to foresee what will happen; but there is a very hopeful spirit amongst engineers and industrialists here at the moment, and it is firmly believed that the many difficulties will be surmounted and a peaceful and that a speedy end will be found to the controversy.

Lower Values in Nut and Bolt and Fencing Irons.

The market for Staffordshire bar iron continues rather slow, the engineering dispute holding up some business which the makers of best bars were expecting to receive. The price for marked bars remains firm at £14 10s. per ton, but unmarked bars and nut and bolt and fencing irons show a further tendency to weaken. It is difficult to determine the price of merchant bars in existing conditions, everything depending upon the circumstances of the deal. Standard prices are still quoted £12, but merchants state they can buy at £11 7s. 6d. both from Lancashire and Scotland. Nut and bolt qualities are easier again this week. Mills still quote £10 10s., but that price is now rarely obtained, being shaded in almost every instance in order to secure business. Many orders, it is reported, have passed at a few shillings below that price. An endeavour is being made to bring the price of fencing iron into closer relationship with nut and bolt iron, and while some makers are trying to get £10 15s., others are accepting £10 10s., 5s. less than last week. It is stated that little business is procurable at above the latter figure. Small lots of Belgian iron are being sold in the district at £9 10s. delivered here, and more probably would be sold if regular deliveries could be assured. The outlook in the galvanised sheet trade is considered rather more encouraging. Some orders are now looked for from South Africa, and other oversea markets seem to promise better. Mills quote £16 f.o.b. for export and £16 5s. for the home trade. The black sheet mills appear to have been doing a little better than of late. A curious sequel to the rise in steel billet prices is the re-sale of some billets by a local re-rolling concern. There has been lately a good deal of transfer of this class of business to the large steel works, some of which have laid down special plant for the production of small bars, gas strip, &c. In the absence of shipbuilding orders the big steel works are cutting prices to figures which re-rollers consider impossible, in view of the higher values of billets.

Drop in Tube Strip Iron.

So severe has been the competition of steel material that makers of iron gas tube strip have this week abandoned as impracticable, in the prevailing state of the market, the attempt to prescribe a uniform price. For some time past iron tube strip has been quoted at £12 10s. and has had to compete with steel strip at something like £2 5s. per ton less. Despite the fact that tube makers prefer iron, their orders have been going to the steel makers, for price is the one consideration in the market to-day. This week, representative makers of iron tube strip are quoting £11 15s., but business is being done even below that figure. This is a drop of 15s. per ton on the week, but it still leaves a margin of about £1 10s between the prices of the two materials. However, with the nearer approximation to steel prices there has been a slight revival of interest in iron strip, and makers are hopeful of recovering some of the business which has been going to the steel strip makers.

Ironworkers' Wages to be Reviewed.

It was decided at the annual meeting of the Midland Iron and Steel Wages Board that the sliding scale wages rates should be reviewed. It was pointed out by the chairman, Mr. George Macpherson, that the conditions under the three Iron and Steel Wages Boards were unequal, and that sliding scale percentages had been for several years uniformly much higher under the Midland Board than under the others. It is of vital importance and interest to both sides that the incidence of the Midland scale should be examined. The Board has always been a powerful factor in the cause of industrial peace, and it is hoped on all sides that the co-operation and goodwill which have characterised its past history will be applied to the solution of present and future problems, to the lasting benefit of the local iron, steel, and kindred industries.

Midland Smelters Seek Export Business.

Midland smelters who have found the home market for pig iron contracting under the pressure of the dispute in the engineering industry are seeking other outlets abroad. Midland prices have recently compared favourably with those of the Cleveland district, and one or two export orders have been secured for this district; but Midland furnaces depend chiefly on the home trade, and in view of the engineers' lock-out some contracts are being held up. A number of pig iron sales have, however, taken place, in some cases covering quantities ranging from 200 to 300 tons up to 1000 tons. Sales generally are few and of small dimensions. There is no perceptible break in prices. Producers say they cannot afford to submit to further sacrifices. Some good buyers whose stocks are now low consider the present juncture quite favourable for buying material. A typical selling price for pig iron is, for Derbyshire forge £3 15s. and for foundry £4 5s., both f.o.t. There is an expectation of a considerable accession of business when the air is clear again.

Dearer Steel Billets.

The demand for semi-finished steel is sufficiently strong to enable local steel works again to put up their prices. Until a few weeks ago they were satisfied with £7 5s. per ton, but an advance of 5s. a fortnight ago brought them to £7 10s. This week a further 5s. per ton is being demanded, and in some instances it is stated as much as 10s. additional is being asked. One large concern a few days ago quoted £8, and business is said to have been done at prices ranging from £7 12s. 6d. to £7 15s. per ton. This represents an advance of 5s. per ton on last week's price. Some buyers in this district will not concede this price, and it is said that the £7 10s. has in some cases been accepted in order to do business. Some Welsh steel works serving this district are said to have very good tonnages on hand. Rising values on the Continent are reducing the severity of international competition, and the falling off in offers of foreign steel is very marked. Such quotations as have been received are of little value, several this week, for example, naming prices well above English figures. As the foreigners usually require several weeks to execute orders, this consideration alone usually leads to the placing of the business at home. English steel makers have found it possible to maintain the slight increase recently made on export quotations. A curious example of this ineffective competition is an offer of foreign shell discard steel, said to emanate from Germany, at £5 15s. per ton. English discard can be bought a great deal cheaper—it is understood that there is any quantity available at £4 7s.—but this high-carbon material is rather unpopular owing to its brittleness and has a very limited usefulness. It is, however, considered fairly suitable for pit rails and similar requirements, where no great strain is involved. It is understood the Government has still a great deal of the material to sell.

Constructional Engineering.

In spite of the engineering labour situation, some encouraging business in the constructional engineering department has recently developed, and there are inquiries about, which, it is confidently anticipated, will shortly materialise. Leading railways require the building of bridges to replace others approaching the danger condition, and various large undertakings of the kind mentioned a few days ago at Sheffield by the chairman of Vickers Limited are known to be pending. It is understood that Rumania requires locomotives and other railway material in considerable quantities. In connection with this prospective business it is stated that it is proposed to use in the manufacture of railway material, such as wheels, axles and tires, some of the thousands of tons of Swedish iron purchased specially for the armour of the four capital ships, contracts for which were cancelled after the Washington Conference.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE general condition of the iron and metal markets is much as it was last week, but the decision of the unions to support the working engineers in their struggle with their employers has had a very bad effect. It was hoped that some way out would have been found, but the chance of success is less, as we write, than it was at this time last week, although some attempts are still being made to find a basis of agreement. In the event of failure it seems certain that a very large addition to the already swollen ranks of the unemployed will be made this week. There is also bad news with regard to the American coal industry, and it is feared that a strike will begin in that country perhaps before these lines are in print.' That there can be any improvement in market conditions until these various troubles are cleared away is not conceivable. The only point for consideration is what can be done to bring about some stable industrial peace.

Metals.

The market for copper is about as dull and stagnant as it can well be. Speculative business on the London Exchange has been fairly active, but consumers' business is, of course, slow. There does not seem to be any fear of a fall in prices, for they cannot be far off the bottom in any case; but with so little to be done at the moment in the usual copper consuming industries few people care to buy, unless it be a small lot for prompt use. The demand in this country for manufactured copper and brass is trifling, but so far no change has been made in the prices for these materials. There is, in fact, little object in making a change, because at present reductions in price would not stimulate consumption. The reports from America suggest that the domestic demand there is also diminishing, and in one case a sale of electrolytic copper was made at under 13 cents per pound. Possibly this weakening of the American demand is connected with a more lively fear of the outbreak of a coal strike; but the impression is that lower prices will be established in America. This may not affect our markets immediately unless the rate of exchange moves more in favour of sterling. There is talk of an extensive scheme for the electrification of British railways to follow upon the schemes for amalgamation, and that would provide an outlet for a good deal of copper; but probably some months, if not the whole of this year, must pass before the demand for copper resulting from such a scheme could materialise. Hence a quiet time in the copper market seems to be assured for a month or two at any rate. There seems to be no reason why consumers should buy in advance of requirements lest the market should run away from them. The demand for tin is like that for copper, very slow; but the prices do not show any serious alteration. Of course, the Manchester market is directly affected by the engineering stoppage, but the South Wales demand—which is not so affected—is also very small, and the Continent is not taking any interest in the metal just now. So far as can be seen, there are no indications of such a revival in the rate of consumption as would make any impression on the reserves of stock, and in that case these reserves may continue to weigh upon the market for months. In the market for lead there has been no striking change, but the home demand seems to be weakening, and the buying for consumption is in rather small lots. There is also less inquiry from the Continent. It is true that the Spanish strike still hinders supplies of Spanish lead; but a feature of the present situation is that there seems to be a sufficient supply without Spanish assistance, and this is surely ominous for the future of prices. Spelter remains a steady market, and there is a good demand from home galvanisers, while neither Germany nor Belgium offers much metal. American competition in Europe seems to be waiting merely for a further rise in the exchange.

Pig Iron.

The market here for foundry iron is almost without business, and both buyers and sellers are waiting to know whether the negotiations now going on will lead to a settlement of the engineers' lock-out. There seems to be an opinion here that we shall see the shops opened again next week, and in that case there will be a revival of the demand for foundry iron at once. Possibly there are some few orders held back and waiting to be released, but it is difficult to believe that there will yet be much improvement in the trade. The foundry owners here are still looking for lower prices and are not likely to do more than buy small lots from hand to mouth, even if the engineers are back at work next week. The announcement that two Cleveland furnaces are to be put out at the beginning of April is not very reassuring as to the prospects for pig iron, and the hope that during the year most of our idle furnaces could be at work has receded into the background. It is said that continental pig iron prices are beginning to go back again, and this may mean that the export trade from Cleveland will decline. Derbyshire No. 3 pig iron is still quoted here at 92s. 6d. to 95s. per ton delivered, with occasionally a small lot at a little less. Scotch No. 3 is quoted at 117s. 6d. per ton delivered.

Finished Material.

The stagnation in the market for manufactured iron and steel continues, but it is possible that there may be some orders held back because of the lock-out, which will be released if a settlement is reached this week. The nominal prices here remain as they were; but, of course, there is no use in making any change until there is a chance of selling. The continental prices remain without definite alteration, but there is now scarcely any attempt here to sell continental material.

Scrap.

The demand for scrap of all kinds is practically absent from this market. The dealers, however, do not attempt to force sales by reducing prices, and, in fact, it would be quite useless to do so. For heavy wrought scrap the Lancashire ironworks pay £3 per ton delivered. For heavy steel melting scrap there is no market. Cast iron scrap for foundries is quoted from £4 to £4 10s. per ton.

Manchester Ship Canal Enterprise.

The most recent development of the Manchester Ship Canal Company's activities is the acquisition of a lease of the property of the Shropshire Union Canal at Ellesmere Port, which is at the entrance of the Ship Canal, three miles from Eastham. The property consists of docks, wharves, sheds, coal tips, and other facilities in the neighbourhood of the Ship Canal. By this arrangement the Ship Canal Company will control the transhipment of traffic between barges which can navigate the river Mersey between Ellesmere Port and Liverpool or Birkenhead, the inland places on the Shropshire Union Canal, and the cross-river service. The port has direct railway communication with the Great Western and London and North-Western Railway Company's lines. The main line of the Shropshire Union Canal extends from Ellesmere Port to within 2¼ miles north of Wolverhampton, and connects the towns of Chester, Nantwich, and Market Drayton. A branch line extends from Hurleston Junction, near Nantwich, to Newtown, in Montgomeryshire, passing through Ellesmere, Llanymynech and Welshpool, with branches to Whitchurch, Prees, Weston, Llangollen, and Guildsfield. From the main canal there are also branch lines to Middlewich and Shrewsbury, with a short line from the latter branch at Wappenshall to Wombridge, near Trench, in Shropshire. Altogether the Shropshire Canal Company owns 200 miles of canal and 18¼ miles of railway. At Ellesmere Port it has constructed, besides its docks, a long length of wharfage facing the Ship Canal, which has 20ft. and 24ft. of water alongside.

Manchester Association of Engineers.

The annual meeting of the Manchester Association of Engineers was held at the Memorial Hall on Friday last, when Mr. Daniel Adamson was elected president for the ensuing year. Messrs. E. G. Constantine, W. Fox, A. Saxon, Joseph H. Stubbs, and Mr. Fred J. West were elected trustees, and the following were elected members of council:—Messrs. G. E. Bailey, E. J. Christian, C. W. Hunt, E. Oakden, and H. Pilling. After the formal business had been concluded Mr. Pilling gave a lantern lecture on "Uniflow Engines." The lantern slides included illustrations of different makes of engines and demonstrated the similarity of their general features.

The Engineers' Club.

The ninth annual meeting of the members of the Manchester Engineers' Club was held on Tuesday last and was well attended. The committee's report states that it is intended to commence the extensions of the Club premises in June next, and when the extensions have been carried out they will enable the membership to be augmented considerably. Thanks to the generosity of several members who have handed over their shares in the Club Company, a scholarship fund for the sons of deceased members is being formed. The report states that the total membership at the end of last year was 785, an increase of 40 members during the year. The catering receipts amounted to £14,584, and members' subscriptions £5917. In spite of these there was a loss of £612 on the year's working, but it is hoped that by increasing the Club premises a larger revenue will be obtainable and that the loss will be speedily wiped out. Mr. J. S. Webb was re-elected president, and Messrs. H. N. Allott, B. Thomas, and A. V. Wallwork re-elected on to the committee, together with a new member, Mr. C. Pearce. Mr. J. Oroden O'Brien was re-elected honorary treasurer and Mr. H. Richardson honorary secretary.

Institution of Electrical Engineers.

The annual dinner of the North-Western Centre of the Institution of Electrical Engineers was held on Friday last at the Midland Hotel, Manchester. There was an attendance of about 140 members and guests, including Alderman W. Walker, chairman of the branch; Mr. W. S. Clare Lees, president of the Manchester Chamber of Commerce; Mr. J. S. Highfield, president of the Institution of Electrical Engineers; Dr. H. F. Parshall; Mr. W. E. Burnand, chairman of the North Midland Centre; Mr. R. A. Chattock, chairman of the South Midland Centre; and Mr. G. A. Juhlin, vice-chairman of the North-Western Centre. The toast of "The Institution of Electrical Engineers" was proposed by Mr. W. Clare Lees, who said that the membership of the Institution now numbered 10,000 and was increasing at the rate of 1000 per year. Mr. Highfield, who responded, said that the last stage in connection with the granting of the Royal Charter to the Institution had been completed, the new by-laws had been passed by the council, and they were now only waiting for the Privy Council's approval of the by-laws. He gracefully acknowledged the assistance which had been rendered by the local centres in framing the by-laws. The toast of "The Guests" was proposed by Alderman Walker, who referred to the lock-out in the engineering industry. From knowledge of both sides of the dispute, Alderman Walker said the trouble arose very largely from a misunderstanding of the true facts. He assured the members of the trade unions that the Employers' Federation had no desire to injure those bodies, and hoped that idea would speedily be dispelled, so that the two sides could approach one another and a way out be found, as ultimately would have to be done. Alderman Walker also referred to the necessity for co-ordination between the various engineering institutions to prevent the clashing of their meetings and suggested joint meetings of the members of those institutions.

BARROW-IN-FURNESS, Thursday.

Iron.

There is hesitancy on the part of some buyers as a result of the continuation of the lock-out, but at the same time trade has not been affected to any great extent as yet. One firm is clearing the whole of its pig iron. Should the labour troubles continue the hematite iron trade will certainly suffer. In addition to the Midlands and Scotland, South Wales is beginning to take deliveries and several cargoes have been dispatched. One of the ironworks in the district has developed a considerable business in ingot moulds, which are mostly going to South Wales by sea from Barrow. The fact that prices are not expected to fall is causing both smelters and customers to stock a certain degree, but there are very few, if any, forward orders being placed. As soon as the labour atmosphere is properly cleared it is confidently expected that the iron trade will improve very considerably.

Iron Ore.

There is not much trade in iron ore, and few mines are bringing any quantity up. None is on anything like full time nor are they expected to be in the near future. Foreign ore is not coming in in any quantity; in fact, there has not been a cargo for a week or two. Stocks both at Barrow Docks and at the works are being reduced, and it is expected that there will be more imports shortly.

Steel.

The bricklayers' trouble at the Barrow Steel Works has not been overcome and the working of the rail mills is interfered with again. In other parts of the district the works are only moderately engaged. There have been further shipments of rails during last week for Colombo and Lagos. The hoop mills are at work.

SHEFFIELD.

(From our own Correspondent.)

Lock-out Effects Extend.

THE continuance of the engineers' lock-out has affected this district much more seriously this week than was the case earlier in the dispute. Firms not directly affected have lost a great deal of work. Marine and general engineers are perhaps the largest consumers of Sheffield tool steel, steel castings and forgings, as well as files and small tools. The steel foundries are feeling the effects of the trouble very acutely. They were apparently on the verge of a revival, after a long-continued hand-to-mouth existence, when the lock-out took effect, but this activity has now been suspended. Not only is there no immediate requirement for steel, but buyers are hesitating to place orders for forward delivery because of the uncertainty of the future. Numbers of local firms are said to be feeling the pinch in a financial sense, and though up to the present there have been surprisingly few actual failures among Sheffield firms, this pleasant record is likely to be lost unless work can very soon be secured. There is not the least doubt that many steel makers are working for nothing just now in order to keep the furnaces fully employed. Even at the recently advanced price of £7 15s. for soft basic billets, the production is said to be unremunerative, but there are still lots to be had at £7 5s., which must represent an even greater loss. This policy, at any rate, did seem to be stimulating business to some extent. Siemens billets are down to £10, and here, again, also local makers cannot produce at the price. The reduction in this case was no doubt due to competi-

tion from the North-West Coast, which has been sending in supplies at this or even lower figures for some time past.

Profits and Losses.

While on the subject of production costs and the financial effects of the depression, it is of interest to note from the recently issued accounts of a few typical local concerns how the storm has been weathered. The figures, of course, relate to last year's operations. Hadfields, Limited, have managed to show an increase in their profits of over £50,000—£158,157, as against £107,856 for 1920, which was considered something of a boom year. This pleasant condition of things is, however, explained by the fact that owing to the considerable volume of orders in hand at the beginning of the year, the effects of the general depression in the engineering industry were not acutely felt until the latter part of the year. Cammell Laird and Co., Limited, whose accounts have also been issued this week, report a profit of £170,487, as compared with £260,632 in the previous year. Bessemer and Co., Limited, on the other hand, have to disclose a loss on the year's working of £19,088—the first time in the thirty years' history of this concern that the balance has been on the wrong side; there is, however, an accumulation of past years' surpluses amounting to £37,609. Sheffield Steel Products, Limited, within the past week has also shown profits amounting to £229,609. This last-named firm, it may be recalled, specialises more in small tools and cutlery and hardware utilities, but the other three concerns referred to are fairly representative of the heavy steel and engineering industries of the district, and these results, all issued within the last few days, would suggest that on the whole Sheffield firms have come through last year's trial much more satisfactorily than many people had feared would be the case. Of course, many of the smaller firms could not show such encouraging results, though at the same time, as was instanced in this column last week, there are still some shops where full time is being worked. These, however, are in a very decided minority, and they are a dwindling number.

Help from Overseas.

As has been several times suggested in this column, the likeliest source of orders on which the steel and engineering industry could be revived is from continental or overseas countries, the railways or other great public works of which are in need either of reconstruction or ripe for development. Confirmation of this seemed to come from Mr. William Clark, the managing director of Messrs. Vickers' Sheffield works, the other day, when he was making his presidential address in connection with the Sheffield Chamber of Commerce. He dropped a hint that there was a possibility of very considerable orders coming from one of this country's allies in the near future, which, he said, would bring a measure of prosperity, not only to Sheffield, but to every other industrial centre. Such a pronouncement made with the authority that Mr. Clark commands, naturally set everybody wondering, but the only foundation so far discovered for his optimistic prediction is that Rumania may be placing orders for a large number of locomotives and railway material if some financial arrangement can be come to between the two Governments. No official pronouncement on this very interesting question has yet been made, but, needless to say, Sheffield firms are awaiting it with the keenest anxiety. Sheffield firms have also been greatly interested in the suggestion put forward by the Federal Inspectorate of Railways in Brazil that it would be greatly to the advantage of British manufacturers of railway rolling stock and material if they were to strengthen their representation in the Republic. There is said to be prospect very considerable railway development in Brazil in the comparatively early future. A proposal under consideration is that British makers of rolling stock and materials should open a joint office in the Republic, with at least one competent engineer to protect and further their interests, his main function being to supply technical advice and to be consulted by the Federal Inspectorate.

Case-hardening of Steel.

Mr. A. P. Hague, chief metallurgist for Cammell Laird and Co., Limited, lecturing before the Sheffield Society of Metallurgists and Metallurgical Chemists, examined the various theories advanced as to how and why iron and steel take up carbon when heated in contact with, or in the presence of, solid, liquid and gaseous carburisers. Whichever theory might be adopted, it might, he said, be safely taken that while carbon alone would carburise mild steel when the two were heated together to some temperature above A.C. 1, the production of a high-carbon case was not due to that specific action, but rather to a reaction between the steel and a gas or gases evolved from the cementing media. It was essential, therefore, that the cementing media be of the right type and capable of producing the right gas, both in quality and in quantity. Solid, liquid and gaseous cements were all used, and Mr. Hague discussed the merits of the various kinds. Of case-hardening steels, carbon 3 per cent., nickel 5 per cent., and nickel-chrome were quoted as examples and their chemical and physical properties were discussed. Incidentally, the lecturer paid a tribute to the efficiency and completeness of the research and metallurgical laboratories in the Sheffield steel works. If only the steel user would more often lay his troubles before the skilled metallurgists to be found in almost all the steel works in Sheffield, many of those troubles would vanish.

Making their Own Gas.

Following on complaints of the high cost and poor quality of the gas supplied by the Sheffield Gas Company, comes the news that some of the sufferers are about to install their own gas-making plant. One of these, Mr. George Clark, a well-known steel manufacturer, who led the protest against high prices, says he will be able to produce his own gas by means of a plant which he has on order at less than half the cost charged by the Sheffield Gas Company. This calculation includes the actual outlay, depreciation, cost of making the gas, attention to the machinery, and other incidental charges. Taking anthracite coal at 40s. per ton—the present price is 35s. 6d.—when working on a full load, Mr. Clark estimates his gas will cost him £3000 per annum instead of the £8000 that would be the cost of an equivalent supply from the gas company. The plant he is putting down will have a capacity of 950 horse-power continuous load.

The Coal and Coke Position.

The engineering lock-out is, of course, adversely affecting the fuel position as well as manufacturing concerns. There is naturally a very much smaller demand for industrial purposes; the export trade *vid* the Humber ports has also shown a marked falling off during the past week, doubtless explained by the fact that overseas buyers are holding off the market as much as possible in expectation of further price reductions. As a result of these conditions, many pits in this district are working short time, and while there are some stocks in evidence they are not particularly large ones. Collieries are not disposed to make any further price reductions, and indeed in view of the substantial losses that are being made, many are not in a position to make any reductions. It is regarded as highly probable that there will be a further reduction in colliers' wages as a result of the wages ascertainment on which the scale will be based as from April 1st. Pending this announcement, however, there is not likely to be any change in quotations. The fact that many pits have been on short time has increased the cost of production, and this alone is likely to tell against any price reductions. The position of the small fuel market is firmer than a week ago, but the demand for blast-furnace coke is not a strong one, and although there is a considerable amount of selling pressure, prices for the most part are steadily held. One of the best-known figures in the coal and iron world, and especially in the North Midlands district, Mr. Maurice Deacon, has retired from the managing directorship of the Sheepbridge Coal and Iron Company, Limited, after twenty-one years in that position. Mr. Deacon will continue as a director of the company, and he will also retain his connection as a director or consultant engineer to various concerns outside the Sheepbridge group. Mr. Deacon commenced his career with the Sheepbridge Company as general manager twenty-six years ago, and he has piloted that concern to a very flourishing position. He is to be succeeded in the managing directorship by Mr. W. B. M. Jackson. At an interesting gathering of the members of the Midland Section of the Coke Oven Managers' Association, held at Sheffield, four associate members delivered papers on subjects of their own choosing. A committee adjudicated on the merit of the papers, and in giving the awards took into account the originality of the work done. The committee found equal merit in the papers given by Mr. W. Whitehead, Hasland Coke Ovens, on "Chemical Control on a Boiler Plant," and by Mr. C. W. Edwards, Hoyland Silkstone Coke Ovens. They placed next in order the paper by Mr. J. Bradwell, Nunnery Coke Ovens, on "The Routine Analysis of Coal in Coke Oven Practice," and Mr. A. R. Flemming, Silverwood Coke Ovens, on "Coke Oven Records."

NORTH OF ENGLAND.

(From our own Correspondent.)

The "Pig Iron Ring."

THE revival of the "Pig Iron Ring" in Glasgow is viewed with considerable alarm by Cleveland ironmasters. Of the many industrial and commercial changes brought about by the late war the abolishment of this vicious circle by order of the Government stood out as a remarkable revolution. For a great number of years prior to the war the Cleveland pig iron market, through the medium of the public store and the issue of warrants, was almost dominated by the "Ring." Speculators with no direct stake in the industry found in warrants a happy gambling medium, and so long as there were large accumulations of iron in the public store against which warrants were issued, makers were absolutely helpless. On several occasions attempts were made to corner the market. National exigencies brought about the desired change in March, 1916. The stock of iron in the public store became exhausted, gambling in warrants was prohibited, and the Cleveland makers found themselves freed from the talons of speculators. The "Ring" undoubtedly had a deterrent influence upon legitimate trade, and the Cleveland makers had hoped that it had been abolished for all time.

Iron and Steel Workers' Wage Slump.

In no other branch of industry has the fall in wages been so drastic and rapid as in iron and steel manufacture. Another 20 per cent. cut is announced this week by the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England, and the wages of puddlers and other forge and mill workers will now be only 47½ per cent. above the standard. The wages are governed entirely by a sliding scale based upon selling prices, and as an indication of the slump it may be stated that whereas the average realised price of bars and angles for the first two months of 1921 was £26 19s. 7.97d., the average for the first two months of 1922 was only £11 16s. 10.05d. In the last two months of 1921 the average was £13 12s. 10.43d. per ton, and on this fall the men's wages are reduced, as already stated, by 20 per cent., dating from Monday last. A gratifying feature is an improvement in the sales, which for the first two months of the year totalled 3648 tons compared with 2170 tons in the preceding two months. Since January, 1921, the wages of the men have been reduced from 225 per cent. to 47½ per cent. above the standard.

Cleveland Iron Trade.

The demand for Cleveland pig iron has fallen off considerably, but this is not surprising in view of the many disturbing factors. Cleveland makers are experiencing keen competition from the Midlands and Scotland, where foundry iron is being offered at substantially lower figures. The quieter demand is also accentuated by the industrial disturbances. This district, however, has one big advantage in being on the seaboard, which enables her to retain a fair share of the export trade. Thus makers have been able to liquidate their stocks, and with fewer blast-furnaces working the output is fully taken up. Indeed, both No. 1 and also forge qualities are almost unobtainable at the moment, and makers are inclined to stiffen the price of the latter. It is pointed out that the official price of 82s. 6d. per ton is merely a minimum quotation, and 85s. is now being asked for No. 4 forge, while mottled and white is not now offered below 80s. per ton. Other quotations are unchanged, No. 1 and siliceous iron being 95s., No. 3 G.M.B 90s., and No. 4 foundry 87s. 6d. There are at present six blast-furnaces producing Cleveland foundry iron, and although two are going out at the Tees Bridge Ironworks there are prospects of two other furnaces re-starting on Cleveland and one on hematite at other works in the district.

Hematite Pig Iron.

There is also a lull in the hematite pig iron trade, buyers hesitating to commit themselves in view of the industrial disturbances. Italy, too, is not buying just now, although there are still a few inquiries. The one bright spot is the German demand. Some good sales have been made despite the further depreciation of the mark, and other inquiries are in the market. Mixed numbers are quoted at 100s., and No. 1 at 101s., though makers might possibly shade these prices for suitable business.

Iron-making Materials.

There is a small volume of business still being done in foreign ore, but sellers of best Rubio keep the price firmly at 27s. per ton c.i.f., although other ores are relatively cheaper. The coke market is displaying a weaker tendency, and 28s. 6d. to 29s. is mentioned as the price of good medium furnace coke delivered at the works.

Manufactured Iron and Steel.

Steel manufacturers report absolutely no improvement in the demand, and, in fact, the engineers' lock-out has strengthened consumers in their determination to hold off the market. There is a little activity in the trade for galvanised sheets, but other branches are deadly dull Prices all round are unchanged.

The Coal Trade.

The Northern coal market is quiet and without any special feature. There is undoubtedly a lull in business, and buyers, either for the home and foreign markets, are marking time. The inquiries from abroad are not so numerous or important as they were, while in cases the full quantities on account of contracts are not being taken out, so that there are ample supplies of coal on offer. Most of the prices are lower, and in second hands supplies are offering rather cheaply. Part of the relapse is due to labour troubles abroad. The threatened national strike in Denmark, together with labour troubles in Sweden and America, are all contributing to the feeling of insecurity reflected in the rushing of supplies forward by the second-hand men at a time when trade is temporarily slow As a result, values are giving strong evidence of shrinking. The industrial crisis at home is also seriously affecting the prospects of the coal trade. The tone of the Northumberland steam coal section is depressed. Collieries are pretty well situated so far as prompt trade is concerned, but they are not adding much to their forward trade. There is not the same slump in gas coals, at least, for the prime sorts. Second steams are patchy, and very susceptible in places to discounting. Coking coal is very slow, and plentifully on offer at lower prices. Bunkers for best and superiors are holding fairly well, but some of the South Durham and other poorer brands are weakening rapidly. The coke position is becoming weak and unsatisfactory for foundries and furnace coke. Gas coke is quieter and easier.

SCOTLAND.

(From our own Correspondent.)

Home Prices versus Foreign.

A FEW days ago the Tramway Committee of the Edinburgh Town Council agreed by a majority to recommend the acceptance of a tender of £1365 for 130 tons of tramway rails and 5 tons of fish plates, required in connection with the scheme to convert the tramway system from cable to electric haulage. This tender was submitted by an English firm, but the rails are German. The lowest offer for British rails was £130 higher. It was also agreed to recommend acceptance of a tender by a German firm in Dusseldorf for the delivery of steel poles for £5463. The lowest British tender was sent in from Newport, Mon., and amounted to £7977.

New Contract.

It is gratifying during such a time of trade depression to note the report of a contract secured by Sir Wm. Arrol and Co., Glasgow, for the construction of workshops and equipment for the Nigerian State Railway, at a cost of £350,000.

Wages Reductions.

The joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board have been notified that an examination of the employers' books for January and February, 1922, shows that the selling price was £12 15s. 6.92d. This means a reduction in wages of 15 per cent. on basis rates. Considerable difficulty is being experienced in settling the reduction in quarrymen's wages. In Stirlingshire, Dumbartonshire and part of Lanarkshire prospects of a settlement are not bright. Employers in the districts named propose a reduction of 20 per cent. The other quarrymen in the West of Scotland have accepted a reduction of 12½ per cent.

Pig Iron.

The slight improvement noticeable in the pig iron

trade a week or two ago has disappeared, as a result chiefly of the engineering trouble. The reduction in the prices of ordinary qualities has not brought out fresh orders; in fact, orders are now scarcer than ever. Makers have great difficulty in disposing of output, even though these are at a very low minimum. A few export orders are reported.

Finished Steel and Iron.

Conditions in the steel and iron trades have not altered during the past week. Apart from industrial disturbances, buyers are not disposed to purchase material at the prices current, and orders are exceptionally slow. Specifications for plates and sectional material are few and far between, and sheets have hardly maintained their recent improvement. Inquiries for the latter from South America and the Far East would appear to indicate an expansion, but orders passing are not now of large bulk, while prices secured are the absolute minimum. Wrought iron and steel tubes are now very slack. Practically all branches of the engineering trade are out of the market at present. The situation at the bar ironworks is not improving, and mills are on short time. While fair concessions can be secured for a specially good specification, prices are maintained at £11 10s. for Crown quality and £12 per ton for best bars, when orders of small quantities are concerned. Employment at the shipyards is scarce, even in the case of general repair work.

Coal.

The situation in the Scotch coal trade is less satisfactory, as a result of a lull in the export demand, and an even smaller turnover than recently in land sales. Supplies are in excess of requirements, and there is an accumulation of loaded wagons at colliery and railway sidings. Idle time at the collieries is now more apparent, and prospects in this respect are not bright. There is still a fair demand for washed nuts, but even these, with the exception of singles, are becoming plentiful. Markets abroad are evidently becoming well stocked. Steamers are now fairly plentiful, and freights are more favourable, but buyers everywhere are acting with great caution. The home demand for industrial consumption is extremely poor, and household coal is quiet and easier in price, supplies being now obtainable from 1s. 8d. to 2s. 1d. per cwt., according to quality and district. Fifeshire has been least affected by the engineering crisis so far, but in the West of Scotland and also in the Lothians irregular employment is increasing as a direct result of the lock-out. Shipments from the two last-named districts dropped considerably on the week, while those from Fifeshire were almost maintained. Aggregate shipments were 231,106 tons, against 273,505 tons in the preceding week and 278,776 tons in the same week in 1913.

Another Blantyre Colliery Closed.

The Blantyre district was at one period the best mining centre in Scotland, and employed 4500 miners. This number has now fallen to 3000. It has just been intimated that Udston Colliery has been closed down and the work of dismantling already begun. This follows on the closing down of Craighead and No. 4 Blantyre collieries in the same district.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

SINCE I wrote a week ago there has been extremely little movement in the conditions prevailing in the South Wales coal trade. It is equally true that the outlook has not improved, unless the strike in the American coalfield at the end of this month turns out to be on a greater scale than is generally anticipated and its duration longer than is at present thought likely, in which event the demand for coals from this country may expand and values advance appreciably. At the moment, however, the probability of a stoppage in the American coalfield does not appear to cause much perturbation in any particular quarter, and it is evident that operators are inclined to await the progress of events. The only inquiry on the market is for about 50,000 tons of Admiralty and Monmouthshire coals on account of the Chilian State Railways for delivery over a period of five or six months from April, but otherwise the market appears to be practically bare of any real inquiry for coals, especially for fairly early loading. Many collieries are very fortunate in having booked up orders a month or so ago for shipment during next month, and in some cases up to the end of May. On the whole they are in a comfortable position, but were it not for this business on their books they would be in a very bad way, as the demand has to a large extent dried up. Italy has been overstocked with coals. A month or so ago importers speculated on the future demand being brisk, but the quantity arranged has turned out to be in excess of consumers' requirements, and, in addition, the strike of dock workers at the West Italian ports has not helped matters, as cargoes have been accumulating there, and the best prices that importers can secure for unsold coals are about 2s. per ton less than what the coals can be bought here at and shipped to Italy. The market for coals in Italy has broken, and in the face of the values ruling, it cannot be expected that there will be much inquiry for fresh cargoes from that country, until the stocks there are absorbed, or until the prices of coals here have come to a lower level. The French market also shows no improvement, and the position all round appears to be that consumers want to secure their future coal requirements at something below the cost of supplying them. If this attitude is persisted in, then either coal prices or freight rates will have to come down, or perhaps both. So far as the latter are concerned, it is very difficult for them to fall any further, especially in the case of tonnage employed in the near trades, as rates are now down to an unremunerative level, and many owners are laying up their boats.

Coalfield Unemployment.

Even now the position regarding the question of work in the coalfield is not satisfactory in some parts. Reference was made last week to notices having been served upon about 600 miners at the Lower Deep Colliery, Blaina, but since that time the Ebbw Vale Company has issued fourteen days' notices to the whole of the workmen employed at the Prince of Wales Colliery at Ebbw Vale. This action, which, it is understood, has been adopted because the colliery is unremunerative, has caused a good deal of feeling in the district affected, as 1000 men are concerned. Trouble arose over the question of allowances when the Ebbw Vale pits were reopened last August. The company reopened them on the understanding that the payment of abnormal allowances should be stopped, but eventually it was agreed that a 50 per cent. reduction in these allowances should be made pending the introduction of a new price list. This matter was submitted to an arbitrator, who, however, referred the parties back to effect a settlement themselves if they could, but so far no terms have been arranged. Responsibility for this state of affairs is placed upon the men, but the latter's leaders deny this, and attribute the blame to the officials of the company. As regards the other side of the employment picture, Labour Exchange returns show that there is an improvement in the Rhondda Valley, and whereas four months ago there were 12,000 unemployed, it is now estimated that there are not more than 3500 unemployed. In the Tonyrefail district a considerable improvement is looked for in the near future, as structural alterations are being proceeded with at the Coed-ely pits with a view of working the Pentre seam, and this is calculated to absorb hundreds of men. The management of the Blaenavon collieries is reported to have given an undertaking to develop its mines so that 200 unemployed miners who were given notices some months ago might be reinstated. The announcement is also made that a new seam of coal has been discovered at the Tylacoch New Shaft, Treorchy. This seam is 4ft. thick, and there is a large area of steam coal of excellent quality, so that in the future it is hoped that work for a considerable number of men will be forthcoming.

Miners and Strikes.

The Executive Council of the South Wales Miners' Federation, on Saturday last, adopted the scheme of co-ordination drawn up by the General Council of the Trades Union Congress. This scheme lays down that every trade dispute shall be dealt with by the General Council of the Trade Union Congress with power to call levies. The M.F.G.B. recommends that the scheme should be voluntary, but the South Wales Executive decided not to accept this, but agreed that it should be compulsory. This decision means that in future the M.F.G.B. will not have the power to call a strike in the industry, and that there will not be a stoppage of miners without the endorsement by the General Council of the Trade Union Congress.

Dock Working Hours.

The prospect of a satisfactory ending to the negotiations concerning a revision of the working hours at the docks in this district is by no means bright, particularly in view of the decision of the members of the Cardiff, Penarth and Barry Coal Trimmers' Union. At the last conference of representatives of the two sides, the suggestion was put forward that two nine-hour shifts should be established with a break of one hour for meals, and it was arranged that there should be a further conference on the 30th inst., but in the meantime the coal trimmers of this district have had a meeting and have resolved to adhere to the working hours now in operation and to decline to consider any re-arrangement on the ground that the employers are responsible for the present disorganised state of the industry and wastage of time at the dockside. The men's leaders urged that they should be allowed a certain amount of freedom of action to enable them to continue negotiations with the employers, but the men appeared very determined, and in view of the resolution passed, the leaders are tied, and the possibility of a settlement being arrived at on the lines of two nine-hour shifts, as suggested, is consequently not enhanced.

Current Business.

The steam coal market has certainly become very dull during the past week so far as the inquiry for coals for prompt shipment is concerned, but still loading operations are fairly active, and there is a good list of steamers on stem. It is pretty certain that present prices will be maintained very well for the next week or two, but the general view is that after the Easter holidays weakness will begin to show itself unless there is a very marked improvement in the demand between then and now, though exactly where it is to come from is a question. Best Admiralty large is quoted at 27s. 6d., and second qualities at 27s. Superior Monmouthshire large coals stand about 26s. 6d. to 27s., and other grades are about 23s. to 26s. 6d. Smalls are more plentiful, with the best descriptions at 19s. to 19s. 6d., and inferior sorts ranging down to 12s. Patent fuel and coke show no change, and pit-wood is quoted at 32s. to 32s. 6d. The anthracite coal market is very irregular. Large coals and cobbles and nuts are easier, but beans and peas are steadier, while rubbly culm and duff coals are firmer.

Latest News from the Provinces.

THE MIDLANDS AND STAFFORDSHIRE.

The Birmingham Bonus Dispute.

THE negotiations that have been taking place in the Birmingham and district (engineering) allied trades since February 1st between the Employers' Association and the National Union of General Workers and the Workers' Union, on the question of wages cuts, have reached a stage in which the Workers' Union has come to terms with the employers, and has accepted their latest proposals, which will have the effect of reducing the existing 26s. 6d. war time bonus by 16s., in three cuts, by the middle of July. The National Union of General Workers, however, has refused to depart from its view that it should be the subject of a national agreement.

WALES AND ADJOINING COUNTIES.

Swansea Metal Exchange.

The conditions show no change so far as the tin-plate industry is concerned. Stocks are reduced, and the outlook is fairly good, with the result that present prices are firm. Owing to the depression prevailing, the Port Talbot Steel Works have been idle all this week, 1500 men and boys being affected.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. C. P. SANDBERG, C.B.E., M. Inst. C.E., has been appointed by the Ministry of Communications, Pekin, as technical delegate at the forthcoming International Railway Congress in Rome.

MESSRS. ROUSE AND GRASEBY inform us that they have taken over the business of brewers' and automobile engineers carried on by the Regent Engineering Company at Beavor-lane, King-street, Hammersmith, W. 6.

THE STAVELEY COAL AND IRON COMPANY, Limited, advises us that its London office address has now been removed from Caxton House, Tothill-street, to 34, Victoria-street, Westminster. The telegraphic address and telephone number remain as before.

A PARTNERSHIP has been entered into between Mr. E. H. Phillips and Kent Bros. Electric Wire Company, as from March 1st, and has been registered under the title of Kent Bros. Electric Wire Company and E. H. Phillips, for the manufacture and supply of silk, cotton and enamel copper wires. Their London office is at 37, King-street, Covent Garden, W.C. 2.

LICENCES, in addition to those already granted to Steel, Peech and Tozer, Limited, and the Patent Shaft and Axle-tree Company, Limited, for the application of the Sandberg sorbitic steel process to the manufacture of railway and tramway tires, have recently been made to Taylor Bros. and Co., Limited, the Monkbridge Iron Company, Limited, Cammell Laird and Co., Limited, and Henry Bessemer, Limited.

F. W. BRACKETT AND CO., Limited, of Hythe Bridge Ironworks, Colchester, ask us to state that they have been appointed buying agents in England for a very large and important group of mines in South America. Their clients wish to have complete and up-to-date catalogues of mining machinery, general engineering plant, machine tools, electric motors, woodworkers' tools and general stores, and interested firms are asked to send their catalogues in duplicate to Hythe Bridge Ironworks, Colchester, so that they may be forwarded to the mines.

EDUCATIONAL INTELLIGENCE.

THE Chair of Civil and Mechanical Engineering in the University of Leeds will shortly be vacant, owing to the resignation of Professor J. Goodman, who has occupied it since 1890. The University has appointed a committee to recommend a successor to Professor Goodman.

"ARCHIBALD DAWNAY" SCHOLARSHIPS IN CIVIL ENGINEERING.—The late Sir Archibald Dawnay bequeathed a sum of money to the London County Council for the provision of scholarships tenable in civil engineering courses. For the present one scholarship will be awarded each year to a candidate between sixteen and eighteen years of age who has passed, or is exempt from, the matriculation examination of the University of London. The conditions of award are similar to those for the Council's intermediate technical scholarships. The "Dawnay" scholarships will be tenable for two or, in some cases, three years in the course in civil engineering in the Battersea Polytechnic, the Northampton Polytechnic, or the Finsbury Technical College. Additional institutions at which the scholarships may be held may be approved in future. The maintenance grant provided will be £110 a year, from which the scholar will be required to pay his tuition fees, &c. Candidates will be required to comply with the Council's general scholarship regulations with regard to residence, nationality, &c. Further information and application forms (T.2/274) may be obtained from the Education Officer, New County Hall, S.E. 1, and must be returned to those offices on or before May 1st, 1922.

SCHOLARSHIPS IN ART OR SCIENCE AND TECHNOLOGY.—The London County Council will be prepared to award in 1922 (a) twenty-five technology and science scholarships, (b) twenty-three art and artistic craft scholarships. The scholarships will be tenable for two years at full-time day courses at institutions at which higher instruction in technology, science, art or artistic crafts is given, and may be extended for a third year. In some cases a maintenance grant, assessed on the merits of each individual case, will be provided, but it will not exceed £160 a year. Scholars will be required to pay their own incidental expenses, including examination fees, modelling expenses, books, apparatus, &c. The Council will also be prepared to award intermediate scholarships and free places in the senior day technical courses in engineering, technical optics, building, chemical trades, &c., at various institutions. The scholarships and free places are, as a rule, tenable for two or three years, but not beyond the end of the school year in which the age of nineteen is attained. They provide free tuition in approved courses and (in certain cases) an annual grant. Further information and application forms may be obtained from the Council's Education Officer, Room 539, New County Hall, S.E. 1.

UNIVERSITY COLLEGE, LONDON.—According to the annual report of the University College Committee, the total number of students enrolled during the session 1920–21 was 3143 (1835 men and 1308 women). Of the total number, 2408 (1506 men and 902 women) were taking day courses; 502 (191 men and 311 women) evening courses; 233 (138 men and 95 women) vacation courses. The day course students included 432 (326 men and 106 women) post graduate and research students. Of the total, 2758 came from homes in the United Kingdom; 212, including 76 post graduate and research students, from various parts of the Empire—India sending 50, Canada and New Zealand 8 each, Australia and South Africa 4 each; from European countries there were 324—59 from France, 50 from Russia, 40 from Sweden, 36 from Switzerland, 25 from Holland, 24 from Norway, 23 each from Belgium and Denmark, 14 from Italy. There were 16 from the United States of America, 10 being undergraduate and 6 research students. From other countries the largest number—23—came from Japan, of which 14 were doing post graduate and research work. One hundred and forty-five students took University degrees during the year, of which 33 were higher degrees. Eighty-nine students obtained diplomas. These included 21 in the newly instituted branches of journalism and librarianship, and 21 in public health. The College has for many years taken an active part in promoting adult education by providing public lectures that are open without fee. Upwards of 8000 persons attended these lectures during the session 1920–21.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	28/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	27/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 7 6	—
No. 1 Foundry	5 0 0	—
No. 3 ,,	4 15 0	—
N.E. Coast—		
Hematite Mixed Nos.	5 0 0	5 0 0
No. 1	5 1 0	5 1 0
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 2 6	4 2 6
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
Midlands.		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
Part Mine Forge	*None offering.*	
North Staffs. No. 3 F'dry	4 5 0 to 4 10 0	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 0 0	—
,, Forge	3 10 0 to 3 12 6	
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 5 0	
Forge	3 12 6 to 3 15 0	
(3) Lincolnshire—		
Basic	4 0 0 to 4 5 0	
Foundry	4 5 0 to 4 10 0	
Forge	4 2 6 to 4 5 0	
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 10 0 to 5 15 0	

MANUFACTURED IRON.

	Home. £ s. d.	Export £ s. d.
Scotland—		
Crown Bars	11 10 0	—
Best ,,	12 0 0	—
N.E. Coast—		
Common Bars	12 0 0	—
Tees	14 10 0	—
Lancs.—		
Crown Bars	12 0 0	—
Hoops	14 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	13 0 0	—
Hoops	14 0 0	—
Midlands—		
Marked Bars (Staffs.)	14 10 0	—
Crown Bars	11 10 0 to 12 0 0	
Nut and Bolt Bars	10 10 0 to 10 15 0	
Gas Tube Strip	12 10 0	—
Hoops (*Nom.*)	14 0 0 to 15 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	14 0 0	—
Ship Plates ⅜in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ⅜in.	11 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	£16 10 0 to 17 0 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 10 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 5 0	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
Manchester (*Prices irregular and uncertain, unchanged*)—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
Sheffield—		
Siemens Acid Billets	10 0 0 to 11 0 0	
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Soft ,,	7 15 0	—
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
Midlands—		
Small Rolled Bars	9 0 0 to 9 5 0	
Bessemer Billets	7 10 0 to 8 0 0	
Hoops	12 0 0	—
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (24 W.G.)	12 10 0 to 13 10 0	
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 5 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/- to 19/6
Block Tin (cash)	142 12 6
,, (three months)	144 5 0
Copper (cash)	58 0 0
,, (three months)	58 17 6
Spanish Lead (cash)	21 17 6
,, (three months)	21 10 0
Spelter (cash)	25 12 6
,, (three months)	25 15 0
Manchester—	
Copper, Best Selected Ingots	63 10 0
,, Electrolytic	65 10 0
,, Strong Sheets	90 0 0
,, Loco Tubes	0 1 1¼
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	23 5 0
,, Foreign	21 15 0

FERRO ALLOYS.

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/6 per lb.	
Ferro Tungsten	1/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£27	10/-
,, 6 p.c. to 8 p.c. ,,	£26 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£25 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£70	26/-
,, 1 p.c. ,,	£88	31/-
,, 0·75 p.c. carbon	£103	37/-
,, carbon free	2/- per lb.	
Metallic Chromium	5/3 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£25 10 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	20/9
,, ,, Ell	21/3
,, ,, Splint	22/3 to 25/-
,, ,, Trebles	22/-
,, ,, Doubles	20/6
,, ,, Singles	18/6
Ayrshire—	
(f.o.b. Ports)—Steam	20/6
,, ,, Splint	22/3
,, ,, Trebles	22/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	19/3 to 22/9
Screened Navigation	27/6
Trebles	22/-
Doubles	20/6
Singles	18/6
Lothians—	
(f.o.b. Leith)—Best Steam	20/9
Secondary Steam	20/3
Trebles	22/-
Doubles	20/9
Singles	19/-

ENGLAND.

	Inland.
(3) N.W. Coast—	
Steams	33/-
Household	40/- to 55/-
Coke	34/-
Northumberland—	
Best Steams	23/- to 24/6
Second Steams	22/- to 23/-
Steam Smalls	14/- to 15/-
Unscreened	21/6
Household	25/- to 30/-
Durham—	
Best Gas	23/- to 24/-
Second	21/6 to 22/6
Household	25/- to 30/-
Foundry Coke	37/6
Sheffield—	
S. Yorks. Best Steam Hards	22/- to 23/-
Derbyshire Hards	21/- to 22/-
Seconds	20/- to 21/-
Cobbles	19/- to 20/-
Nuts	17/- to 18/-
Washed Smalls	11/- to 12/-
Best Hard Slacks	12/- to 13/-
Seconds ,,	10/- to 11/-
Soft Nutty ,,	9/- to 10/-
Pea ,,	7/- to 8/-
Small ,,	4/- to 5/-
House, Branch	37/- to 39/-
,, Best Silkstone	34/- to 35/-
Blast Furnace Coke (Inland and Export)	17/6 to 22/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	27/6
Second ,, ,,	27/-
Best Dry Large	26/6 to 27/-
Ordinary Dry Large	24/- to 25/-
Best Black Vein Large	26/6 to 27/-
Western Valley ,,	26/- to 26/6
Best Eastern Valley Large	26/- to 26/6
Ordinary ,, ,,	24/- to 25/-
Best Steam Smalls	18/6 to 19/6
Ordinary ,,	15/- to 18/6
Washed Nuts	27/6 to 32/6
No. 3 Rhondda Large	30/- to 32/6
,, ,, Smalls	19/6 to 20/-
No. 2 ,, Large	23/6 to 24/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	16/- to 18/-
Coke (export)	30/- to 35/-
Patent Fuel	25/- to 28/-
Pitwood (ex ship)	32/6 to 33/-
Swansea—	
Anthracite Coals:	
Best Large	37/6 to 40/-
Seconds	30/- to 35/-
Red Vein	27/6 to 28/6
Big Vein	37/6 to 40/-
Machine-made Cobbles	45/- to 47/6
Nuts	47/6 to 50/-
Beans	47/6 to 50/-
Peas	22/6 to 25/-
Breaker Duff	9/6 to 10/-
Rubbly Culm	14/- to 15/-
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 22/6
Smalls	13/- to 18/-
Cargo Through	18/6 to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Raw Material.

For a long while past manufacturers have been doing their best to bring down prices under the impression that there can be no hope of an improvement until values come back to a level that consumers will pay. The downward fluctuations of prices have generally been accompanied by a little more activity, and the fact that the declension has not been continued, and has in many cases given way to a further advance, is deplored by no others more than manufacturers themselves, who are continually impressing upon Government the necessity of taking such measures as will reduce the cost of production, notably in the lowering of railway rates. Towards the end of last year it was thought that the prices of iron and steel had started on a downward movement. Everything seemed to be in favour of lowering prices. All the makers were in need of orders and were ready to consent to almost any sacrifice to get them, and in the belief that raw material prices were coming down many of them took contracts that entailed a loss. Since then there has been a general hardening of raw material values, due apparently to the policy of blast-furnace owners, who are selling a large part of their production abroad at low prices and are keeping up rates on the home market. No. 3 pig iron has gone up 100f. a ton since last November. In malleable iron and other products, in which wages enter largely into the cost, prices have appreciably advanced. The effect of the shorter hours in keeping prices at an uneconomical level is so obvious that the agitation in favour of modifying the application of the Eight Hours' Bill is rapidly gaining ground, and recent declarations of mineowners tend to confirm the results obtained with the operation of this legislative measure in other industries in which the production per man is said to have fallen by 20 to 25 per cent. Until the men produce more for the wages received there can be little hope of prices being brought down to a level at which business can be done.

Dumping.

Meanwhile a good deal of nervousness is being felt over the threatened competition due to the further collapse of the mark and to the importation of iron and steel from Britain. For the moment the heavy duties imposed against German goods are considered as a sufficient protection, but if the depreciation of the mark should continue it is believed that the time will come when it will be necessary to revise the tariff against the Central European States. The fear of German competition through the depreciation of the mark may be justified to a certain extent, but as a fall in money values appreciates the values of commodities, the productive cost does not decline in the same proportion, and a proof that other factors influence the cost of production is shown by the importation of British metallurgical products. The French allude to this as "dumping," quite forgetful of the fact that they are themselves doing the same thing. They are now considering what measures should be taken in the interests of home producers, and while French consumers are objecting strongly against any modification of the fiscal arrangements which may increase the cost of raw material, it is being urged that the duties should be increased upon those iron and steel products which are finding their way into this country. The tariff war has, however, so far complicated the situation that the troubles incidental to protective duties can often only be overcome by putting them up still higher, and the failure of the present fiscal system to bring prosperity to trade has impressed upon the commercial classes the necessity of carrying out commercial arrangements with different countries as soon as possible.

Shipbuilding.

The complaints of shipbuilders have now reached the Senate, where a debate has taken place on the ways and means of removing the obstacles that stand in the way of the industry. It is suffering more particularly from the social legislation which hampers shipping more than in any other country. It is doubtful whether much can be done in the way of repealing legislation that has been passed in the interests of the men, but it is universally admitted that the greatest mistake made was to apply the eight hours' day to the mercantile marine before it was adopted elsewhere, the result being that French shipowners are burdened with unnecessary charges that make it almost impossible to carry on competition with foreign shipping companies. It is said that the eight hours' day costs the shipowners 117 million francs a year. The Government has long made up its mind to modify the application of the Bill and eventually to suppress it, and it is expected that the necessary amendment will be introduced very shortly. Meanwhile it was stated that thirty-nine slips were occupied in the shipyards out of a total of ninety, while 200,000 tons of shipping had been laid up, which is, however, by no means considerable in view of the total tonnage now owned in this country.

Foreign Trade.

The new system of fixing the values of imports according to the declarations of importers renders it almost impossible to make a comparison with the exports, which are still based upon the method of valuation of 1919, and it is stated that the values declared by importers are about 33 per cent. below what they would have been under the old system of valuation. During the first two months of the year the imports were estimated at 3334 million francs, a decline of 748 million francs as compared with the similar period of 1921. The value of the exports was 3492 million francs, a declension of 369 million francs. If, however, the imports were valued in the same way as the exports it is believed that they would have exceeded the exports by something like 1300 million francs. This would seem to be confirmed by the tonnage, for during the two months the imports totalled 7,521,964 tons, an increase of 593,617 tons, and the exports 3,073,964 tons, an augmentation of 274,304 tons, practically the whole of this improvement being due to iron, steel and coal, which showed an increase both in imports and exports of close upon half a million tons. There was a decline of 9634 tons in the imports of manufactured goods and of 126,852 tons in exports.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

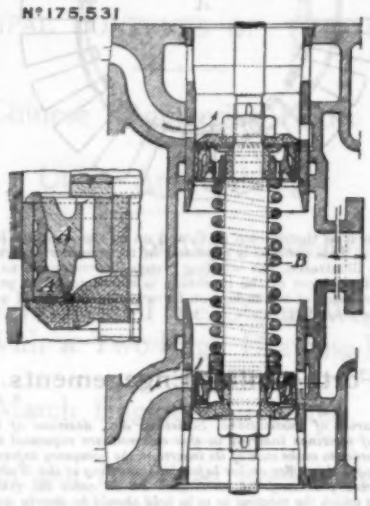
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM ENGINES.

175,531. February 11th, 1921.—PISTON VALVE PACKINGS, F. Dannisu, 37, Route Provinciale, Clabecq, Belgium.

IN the place of split rings, the inventor uses a closed ring to make the piston valve tight, which can be stretched or expanded to make a good sliding joint with the liner. The ring is made of phosphor bronze or steel, and is expanded by means of the conical wedges A A and the spring B.—*February 23rd, 1922.*

N° 175,531

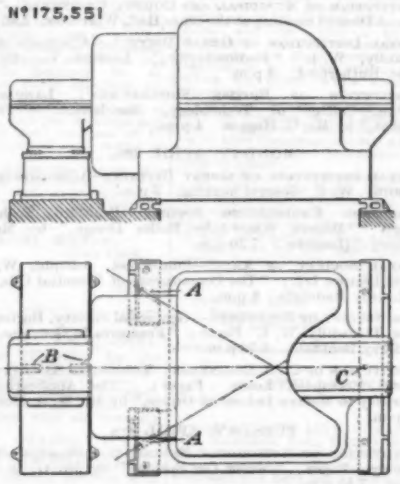


TURBINE MACHINERY.

175,551. March 17th, 1921.—STEAM TURBINES, K. Baumann, Northwood House, Barnfield, Urmston, Lancashire, and the Metropolitan-Vickers Electrical Company, Limited, 4, Central-buildings, Westminster.

It has been found, according to the inventors, that the casings of very large steam turbines expand in such a manner that the usual forms of guides are not satisfactory. They thus introduce inclined guides or keys A A at the steam end of the machine, over and above the usual bearing pedestal keys B B. The keys A A are inclined in such directions that they are parallel with the resultant of the longitudinal and transverse expansions of the casing. The exhaust end of the turbine is, of course, dowelled to the base at C.—*February 23rd, 1922.*

N° 175,551

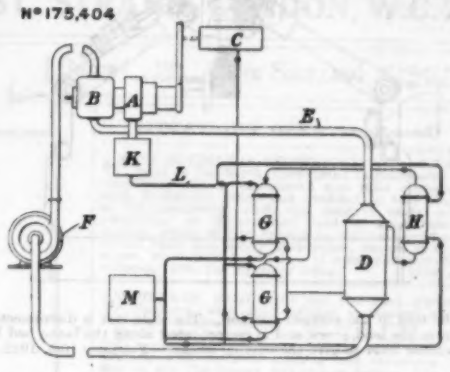


DYNAMOS AND MOTORS.

175,404. November 15th, 1920.—IMPROVEMENTS RELATING TO THE COOLING OF DYNAMO-ELECTRIC MACHINES, William Morrish Selvey, of Independent Buildings, Fargate, Sheffield, and Leslie Robert Morshead, of 17, Victoria-street, Westminster.

According to this invention, exhaust steam is utilised to maintain an absorption type of refrigerating apparatus in operation for cooling the main generator of a turbo-generating set. In the drawing, the turbine is shown at A and the generator at B. An auxiliary steam-driven unit is shown at C, and an air-cooling refrigerator at D. E is a closed air circuit, which includes cooling ducts in the generator, and a fan F which circulates the air through the circuit. The refrigerating apparatus consists of a pair of absorption vessels G and an ammonia condensing vessel H, with the necessary connections and valves to enable the absorption process of refrigeration to be carried out. The absorption vessels are connected by piping to the exhaust of the auxiliary steam-driven unit C, so that the exhaust steam may be directed to the vessels G alternatively to evaporate the condensed or dissolved ammonia therein, and drive it off under pressure to the condensing vessel H, from which it is allowed to pass to and expand in the refrigerator, and it then passes to the other absorption vessel for re-absorption. K is the main condenser, which has its condensation outlet connected with the cooling coils of the absorption vessels. M represents a feed-water heater, which is connected to the outlets from the cooling coils of the vessels G G, so that after taking up heat from the absorption vessels the condensate can be led to the feed-water heater and the heat is thus conserved. The piping may have a connection L to a coil in the condensing vessel H, and arranged so that the water of condensation can be passed through the condenser H and the absorption vessels in series or in parallel, or through the condenser H direct to the feed-water heater.—*February 15th, 1922.*

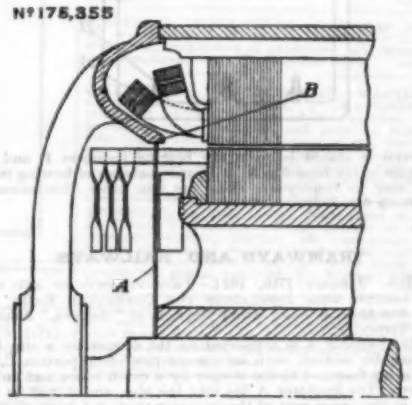
N° 175,404



175,355. November 4th, 1920.—IMPROVEMENTS IN ELECTRIC MOTORS, The Lancashire Dynamo and Motor Company, Limited, of Trafford Park, Manchester, and Robert Stafford McLeod, of 21, Victoria-avenue, Didsbury, near Manchester.

This invention relates more particularly to enclosed squirrel cage motors, and is especially applicable to machines in which the rotor short-circuiting connections possess a higher resistance than usual, in order to meet special requirements. The invention consists in placing the end connectors of the rotor conductors outside the stator casing, and in closing the end or ends of the casing by means of fixed annular extensions and rotating end plates A, through which the conductors pass, a running joint B being made between the extensions of the stator casing and the rotating end plates. The end connectors of the rotor bars are preferably of a modified form, as described in patent specification No. 13,504 of 1908.—*February 6th, 1922.*

N° 175,355

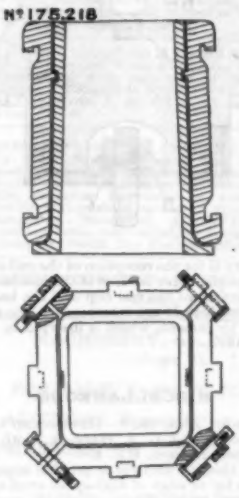


MACHINE TOOLS AND SHOP APPLIANCES.

175,218. April 30th, 1921.—INGOT MOULDS, E. Walton, 6, Whiteley Wood-road, Sheffield.

The inventor proposes to economise in the maintenance of the moulds used in casting steel ingots by making them in several parts with a renewable lining to take the wear. The drawing shows one method of building up the mould, in four parts, held together by bolts and cotters, with the lining kept in place by projections on the casing entering recesses in the lining.—*February 16th, 1922.*

N° 175,218

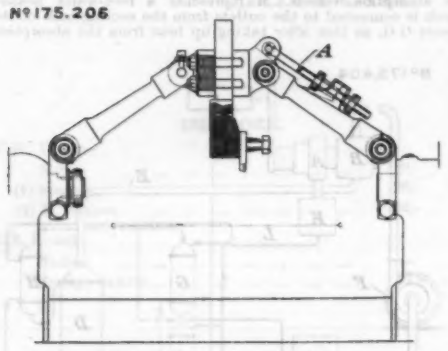


175,206. March 22nd, 1921.—A PLANING ATTACHMENT FOR SMALL LATHES, D. R. P. Jackson, 161, Jamaica-road, Bermondsey, London, S.E. 16.

The inventor mounts his tool on a sort of bridge, which is

fixed between the head and tail stocks, in such a manner that by moving the tail stock the height of the bridge can be varied and the depth of cut thus adjusted. A tie bar A is used to keep

No 175,206



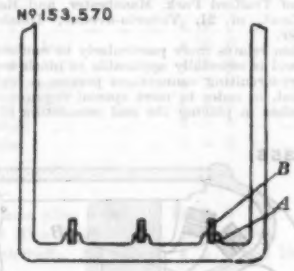
the tool in the vertical position. The slide rest is disconnected from the lead screw and is reciprocated along the lathe bed by a hand lever to give the cutting stroke.—*February 16th*, 1922.

STORAGE BATTERIES.

153,570. October 5th, 1920.—IMPROVEMENTS IN OR RELATING TO ELECTRIC ACCUMULATORS, Société de L'Accumulateur Tudor, of 26, Rue de la Bienfaisance, Paris.

The container of the accumulator is provided with ribs A, which are recessed to form housings for bearing members B for supporting the plates. A layer of any suitable compressible

No 153,570



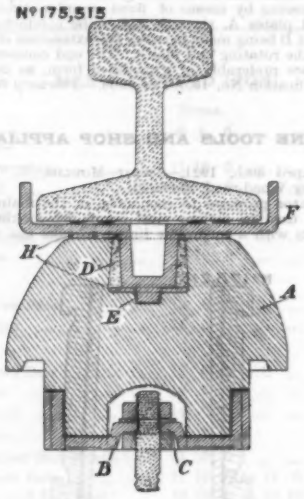
material is placed between the bearing members B and the bottoms of the housings A, and various shapes of bearing members may be employed. There are four other illustrations.—*February 6th*, 1922.

TRAMWAYS AND RAILWAYS.

175,515. January 17th, 1921.—IMPROVEMENTS IN AND CONNECTED WITH INSULATORS FOR CONDUCTOR RAILS AND THE LIKE, William Henry Meyrick, of "Auburn," Ashtead, Surrey.

The insulator A is supported on the sleeper by a clip B of rectangular section, with an inward projecting portion C, the clip being fastened to the sleeper by a coach screw and nut, as shown. The insulator A fits into the clip, and it will be seen that in the upper part of the insulator there is a large cavity D

No 175,515



and a small cavity E for the reception of the rail clip F. Between the rail clip F and the upper surface of the insulator, and between the inward projection of the rail clip and the base of the cavity D felt or other washers H are interposed. The rail clip may be held in position by cement, which is inserted in the cavity D.—*February 23rd*, 1922.

MISCELLANEOUS.

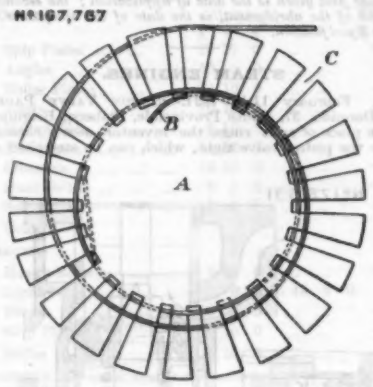
175,495. December 23rd, 1920. HIGH-SPEED CUTTING TOOLS, T. R. Hancock and L. J. Hancock, both of 224, Upper Thames-street, London, E.C. 4.

The object of this invention is to provide improved means for uniting firmly a tip or edge of high-speed steel or alloy, such as stellite, with a tool body. The edge of high-speed metal is cast on to the surface of the tool body after the surface has been prepared by amalgamating therewith copper or the cast iron with is employed for welding purposes, by means of oxy-acetylene or electric welding methods. The copper or cast iron and the surface of the tool body are first brought to the molten state so as to amalgamate the copper or cast iron with the tool body, and the tool is placed in position in a mould composed of electrolytic graphite. The high-speed metal is then cast in the mould on the prepared surface, the copper or cast iron serving to prevent the metal of the tool body from mixing with or altering the composition of the high-speed metal.—*February 23rd*, 1922.

167,767. August 9th, 1921.—IMPROVEMENTS IN HIGH-FREQUENCY SELF-INDUCTION COILS, Edouard Binard, of 2, Rue van Bemmel, Brussels.

A thin disc A of insulating material, with a number of notches, is used for winding high-frequency self-induction coils in accordance with this invention. The insulated wire B is first passed by means of a winding machine through one of the notches, and is then run along the face of the disc and then through another

No 167,767



notch, such as that shown at C, and on to the opposite face of the disc. This process is repeated in the manner shown. In the case illustrated, the winding "step" corresponds to three teeth. The object of the invention is stated to be to produce a large amount of self-induction for a given amount of wire.—*February 9th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, Westminster, S.W. 1. "The Steel Melting Shop," by Mr. D. P. Dickinson. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. Extra general meeting. "The Milling of Screws, and other Problems in the Theory of Screw Threads," by Dr. H. H. Jeffcott. 6 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Victoria Embankment, W.C. 2. Address by the President (Mr. J. S. Highfield). 7 p.m.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School, West Bromwich. Paper, "Internal Combustion Engines," by Mr. J. Robson. 7.30 p.m.

SATURDAY, APRIL 1ST.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—West Midland District meeting at the Shire Hall, Worcester. 2.45 p.m

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Radioactivity." Lecture V. By Sir Ernest Rutherford. 3 p.m.

INSTITUTION OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Manchester. "Plaster Patterns," by Mr. C. Heggie. 4 p.m.

MONDAY, APRIL 3RD.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. General meeting. 5 p.m.

BRADFORD ENGINEERING SOCIETY.—Bradford Technical College. "Modern Water-tube Boiler Design," by Mr. J. Cauthery. (Lantern.) 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C 2. Cantor Lecture III.: "The Constituents of Essential Oils," by Mr. L. Guy Radcliffe. 8 p.m.

THE SOCIETY OF ENGINEERS.—Geological Society, Burlington House, Piccadilly, W. 1. Paper: "Fractures in Concrete," by Mr. Harry Bentham. 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Hotel Metropole, Leeds. Paper: "The Application of Electricity to Modern Industrial Drives," by Mr. W. A. Burgess. 7.30 p.m.

TUESDAY, APRIL 4TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Paper: "Motor Car Springs," by Mr. G. H. Lanchester. 7.45 p.m.

ROYAL SOCIETY OF ARTS: DOMINIONS AND COLONIES SECTION.—John-street, Adelphi, W.C. 2. "New Zealand," by Lieut.-Colonel Sir Thomas Bilbe Robinson. 4.30 p.m.

DYNAMICABLES.—Trocadero Restaurant, Piccadilly, W. Anniversary dinner.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Paper: "Corrosion of Ferrous Metals," by Sir Robert Hadfield, Bart. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE, STUDENTS' SECTION.—Grand Hotel, Colmore-row, Birmingham. Conversazione. Lantern lecture: "With the Wireless Signal Company, R.E., in East Africa, 1916-1918," by Mr. J. A. Cooper. 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS.—The Minories, Towerhill, E. 1. "The Depths of the Sea," by Captain Alfred Carpenter. (Ladies' night.) 6.30 p.m.

WEDNESDAY, APRIL 5TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Sea Encroachment and its Prevention," by Mr. Ernest R. Matthews. 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION MEETING.—Savoy-place, Victoria Embankment, W.C. 2. "Provision of Power for Wireless Telegraphy," by Captain J. H. Whittaker-Swinton. 6 p.m.

THORNYCROFT ENGINEERING SOCIETY.—Works Canteen, Basingstoke. "Engine Tuning, with Special Reference to Carburation," by Mr. Mantell. 7 p.m.

ASSOCIATION OF DROP FORGERS AND STAMPERS.—Chamber of Commerce, New-street, Birmingham. Lecture: "The Making, Forging, and Heat Treating of Nickel-chromium Steels," by Mr. Harry Brearley. 7.30 p.m.

INSTITUTE OF COST AND WORKS ACCOUNTANTS.—Hall of Chartered Institute of Patent Agents, Staple Inn, W.C. 1. Address: "Debatable Points in Works Accountancy," by Mr. R. J. H. Ryall. 7 p.m.

WEDNESDAY TO FRIDAY, APRIL 5TH TO 7TH.

INSTITUTION OF NAVAL ARCHITECTS.—Lecture Hall, Royal United Service Institution, Whitehall. Spring Meetings. For programme, see page 340. 11 a.m. each day.

THURSDAY, APRIL 6TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—The University, Edmund-street, Birmingham. Discussion on the Final Report of the Water Power Resources Committee. 6 p.m.

THE OPTICAL SOCIETY.—Imperial College of Science and Technology, South Kensington. Papers: "Diffraction Halos in Normal and Glaucomatous Eyes," by Mr. H. H. Emsley and Mr. E. F. Fincham; "The Effect of Changes of Curvature at the Focus of an Astronomical Object Glass," by Mr. E. Wilfred Taylor. 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper: "Aerodynamical Efficiency and the Reduction of Air Transport Costs," by M. Louis Brèguet. 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "Protective Apparatus for Turbo-alternators," by Mr. J. A. Kuyser. 6 p.m.

FRIDAY, APRIL 7TH.

DIESEL ENGINE USERS' ASSOCIATION.—At the Institution of Electrical Engineers. "Some Characteristics of Petroleum Oil Used in Diesel Engines," by Mr. Harold Moore.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Evolution of the Elements," by Sir Ernest Rutherford. 9 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. 1. Lecturette, "Engineering in Southern Persia," by Mr. J. W. Maple. 8 p.m.

INSTITUTE OF COSTS AND WORKS ACCOUNTANTS: BIRMINGHAM AND DISTRICT BRANCH.—Chamber of Commerce, New-street, Birmingham. Public lecture on "The Functions of Works Accountancy," by Mr. J. A. Lacey. 7.30 p.m.

SATURDAY, APRIL 8TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Radioactivity," by Sir Ernest Rutherford. (Lecture VI.) 3 p.m.

MONDAY, APRIL 10TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Philosophical Hall, Park-row, Leeds. Paper: "Modern Production and Costing Methods as Applied to Locomotive Engineering," by Mr. A. E. Howell. 7 p.m.

TUESDAY, APRIL 11TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—207, Bath-street, Glasgow. "Rotary Converters, with Special Reference to Railway Electrification," by Mr. F. P. Whitaker. Annual general meeting. 7.30 p.m.

MANCHESTER METALLURGICAL SOCIETY.—College of Technology, Manchester. Paper: "The Causes of Some Defects in Steel," by Dr. Thomas Swindon. 7 p.m.

INSTITUTION OF BRITISH FOUNDRYMEN: BURNLEY SECTION.—Technical College, Ormerod-road, Burnley. Paper: "Some Experiences of Cupola Practice," by Mr. J. Pell. 7.15 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Chamber of Commerce, New-street, Birmingham. Annual general meeting. 7.30 p.m.

TUESDAY, APRIL 11TH, TO THURSDAY, APRIL 27TH.

BUILDING TRADES' EXHIBITION.—Olympia.

WEDNESDAY, APRIL 12TH.

JUNIOR INSTITUTION OF ENGINEERS.—Official visit to the International Building Trades' Exhibition at Olympia. 5 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper: "Marine Engine Design as Affected by Lifeboat Service Conditions," by Mr. A. F. Evans. 8 p.m.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Paper: "The Artesian Wells and Geological Strata of London," by Mr. W. H. Booth. 8 p.m.

TUESDAY TO FRIDAY, APRIL 18TH TO 21ST.

THE CONCRETE INSTITUTE.—Building Exhibition, Small Conference Hall, Olympia. For programme see page 354. 5.30 p.m. each day.

WEDNESDAY, APRIL 26TH.

SOCIETY OF GLASS TECHNOLOGY.—Royal Victoria Station Hotel, Great Central Railway, Sheffield. Fourth annual dinner. 7 p.m. for 7.15 p.m.

WEDNESDAY, MAY 3RD.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual May lecture: "The Relation of the Elements," by Sir Ernest Rutherford. 8 p.m.

THURSDAY AND FRIDAY, MAY 4TH AND 5TH.

IRON AND STEEL INSTITUTE.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting. Annual dinner, Thursday, May 4th, at Connaught Rooms, Great Queen-street, W.C.

TUESDAY, MAY 30TH, TO FRIDAY, JUNE 2ND.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer Meeting in Scotland. Ladies invited. For programme, see page 326.

CHELMSFORD ENGINEERING SOCIETY.—On March 18th the Chelmsford Engineering Society held a successful conversazione to mark the close of the session. The President during the year was Mr. Geoffrey Barrett, managing director of the Hoffmann Manufacturing Company, Limited, and through the courtesy of that firm, the conversazione was held in the large mess-room at its works, the guests being received by the President and Mrs. Barrett. There was a concert during the first part of the evening, after which a tour of inspection was made of various interesting exhibits which had been lent by the principal local firms.